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Norwegian Scientific Committee for Food and Environment

VKM Report 2022: 18

Food and chemical substances relevant for monitoring

Scientific Opinion of the Scientific Steering Committee of the Norwegian Scientific Committee for Food and Environment

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Food and chemical substances relevant for monitoring

Preparation of the opinion

The Norwegian Scientific Committee for Food and Environment (Vitenskapskomiteen for mat og miljø, VKM) appointed a project group to draft the report and the knowledge base. The project group consisted of seven VKM committee members, and two VKM staff members. The Scientific Steering Committee assessed and approved the final report and knowledge base.

Authors of the opinion

The authors have contributed to the opinion in a way that fulfils the authorship principles of VKM (VKM, 2019). The principles reflect the collaborative nature of the work, and the authors have contributed as members of the project group and/or the VKM Scientific Steering Committee.

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VKM would like to thank Monica Andreassen for controlling all data on contribution to exposure in the knowledge base.

Competence of VKM experts

Persons working for VKM, either as appointed members of the Committee or as external experts, do this by virtue of their scientific expertise, not as representatives for their employers or third-party interests. The Civil Services Act instructions on legal competence apply for all work prepared by VKM.

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Summary

At request from the Norwegian Food Safety Authority (NFSA), VKM has identified food groups and food items consumed by the Norwegian population that are relevant for monitoring regarding content of one or more undesirable chemical substances (Figure 1). Undesirable chemical substances were defined as chemical substances in food that may constitute a potential health risk.

VKM has created a knowledge base (an Excel file) as a tool for planning and prioritising monitoring of foods and undesirable chemical substances. The substance groups included in the knowledge base are flavourings, food additives, metals and metalloids, natural toxins, persistent organic pollutants, process-induced contaminants, substances in food contact materials, substances in food supplements, and trace elements. More than 40 different substances were included.

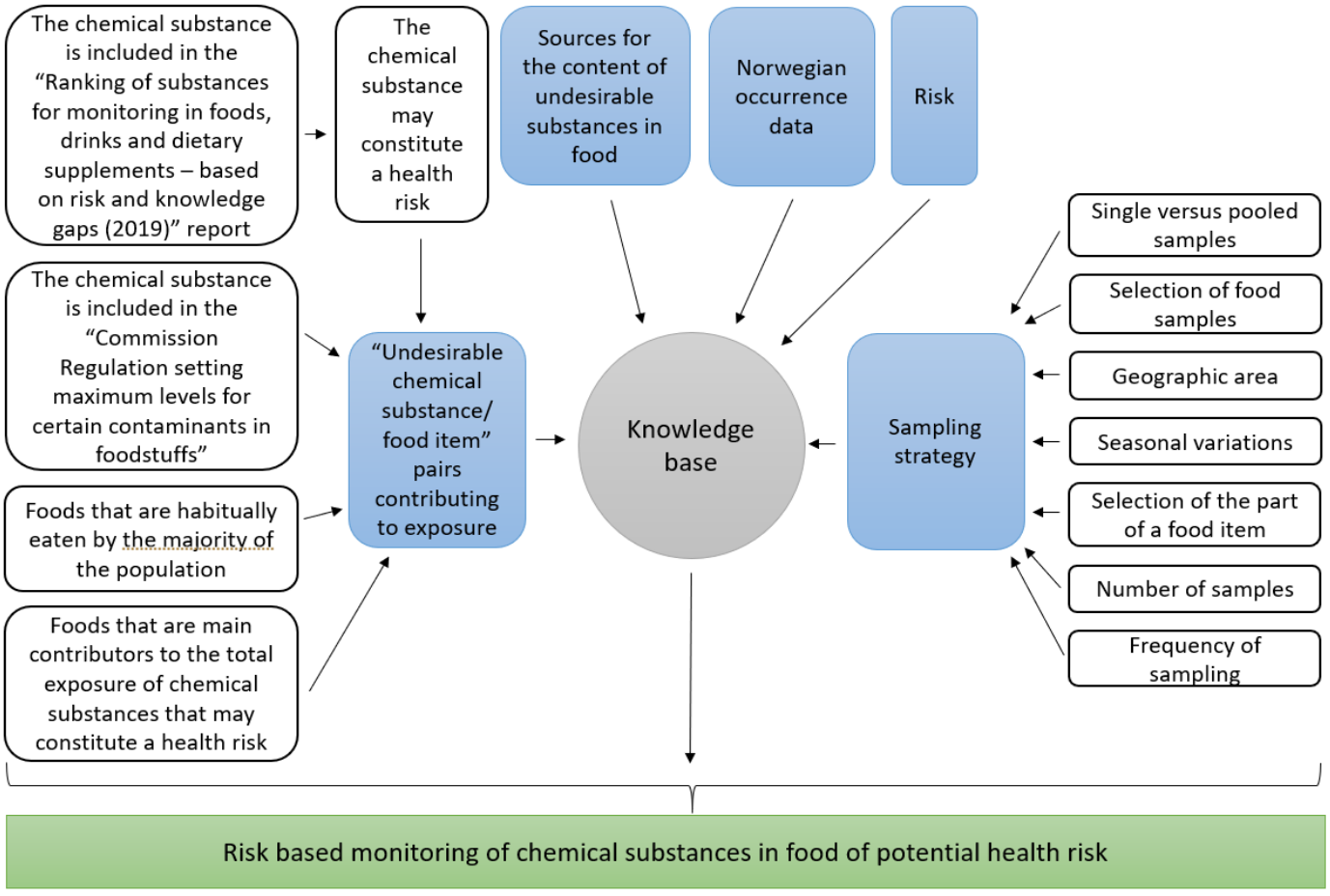


Figure 1. An overview of the knowledge base prepared by VKM and the planned use areas for the NFSA (in green).

Food items that are known contributors to exposure to an undesirable chemical substance were identified from quantitative and qualitative data, mainly from EFSA opinions and VKM risk assessments. Four national dietary surveys were used for identification of food items and food groups habitually eaten by the Norwegian population. The habitual diet was used to identify potential unknown sources of the substances. The information on known and unknown sources was compiled in a knowledge base comprised of 456 "undesirable chemical substance/food item" pairs that were identified to be relevant for monitoring.

For each "undesirable chemical substance/food item" pair, the following information are included in the knowledge base:

- Food category
- Contribution to total exposure, including degree of contribution
- Origin of occurrence data, and availability of Norwegian occurrence data
- Remarks regarding sampling
- Sources of the undesirable chemical substances in food
- Risk (a combined score for hazard and exposure)

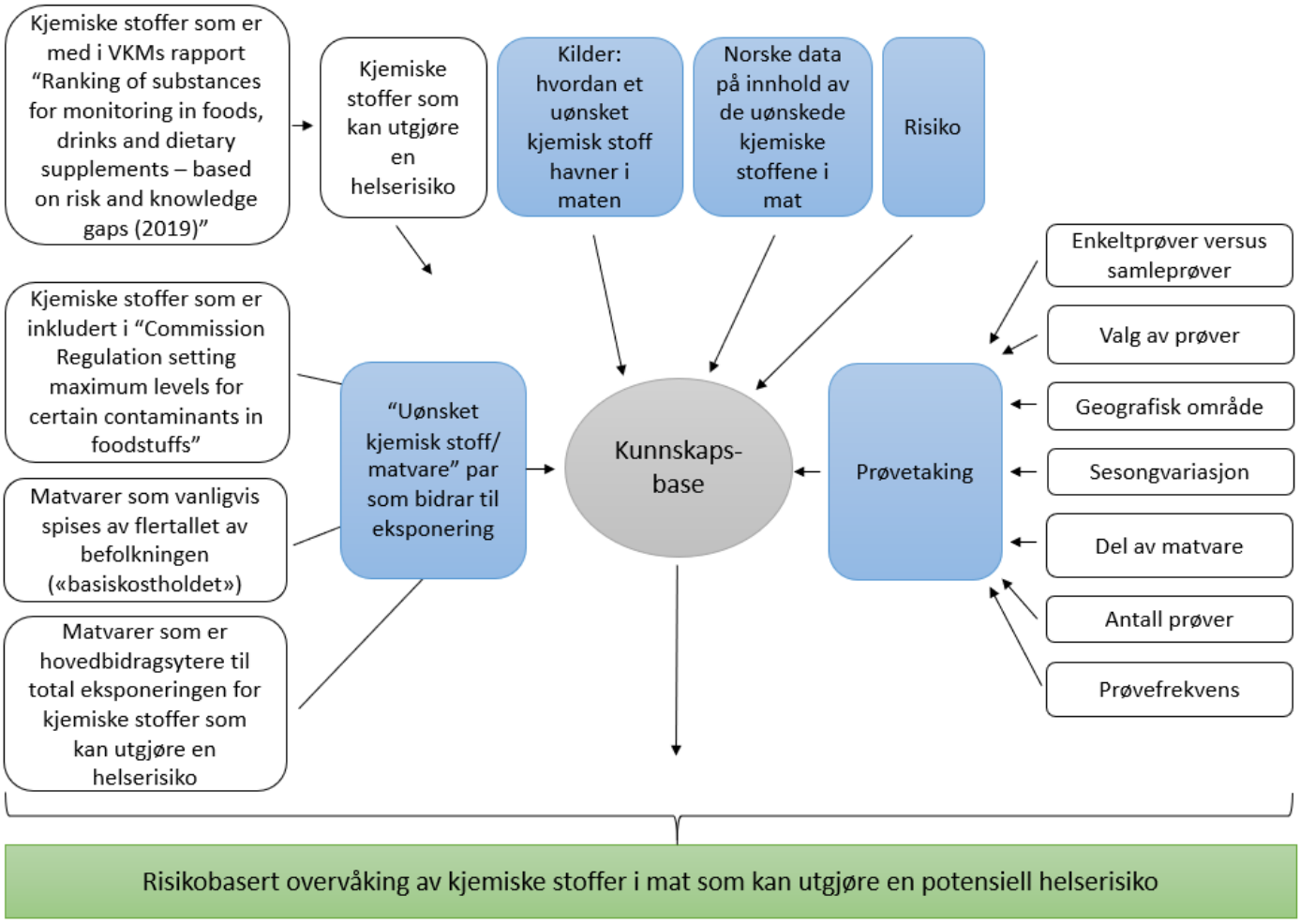
Sampling of food is a complex area. Careful planning of the sampling strategy is needed and several parameters should be taken into consideration, depending on the properties of the chemical substance and the food item. Generic guidelines on sampling strategy, including sample number and frequency, have been provided in the report.

Key words: VKM, health risk, monitoring, Norwegian Scientific Committee for Food and Environment, Norwegian Food Safety Authority, undesirable chemical substance.

Sammendrag på norsk

På oppdrag fra Mattilsynet har VKM identifisert matvaregrupper og matvarer som konsumeres av den norske befolkningen og som er relevante for overvåking på grunn av innhold av ett eller flere uønskede kjemiske stoffer (Figur 1). Uønskede kjemiske stoffer ble definert som kjemiske stoffer i mat som potensielt kan utgjøre en helserisiko.

VKM har laget en kunnskapsbase (en Excel-fil) som et verktøy ved planlegging og prioritering av hvilke matvaregrupper/matvarer og uønskede kjemiske stoffer som bør overvåkes. De stoffgruppene som er inkludert i kunnskapsbasen er aromastoffer, tilsetningsstoffer til mat, metaller og metalloider, naturlige giftstoffer, persistente organiske miljøgifter, prosessinduserte kontaminanter, stoffer i matkontaktmaterialer, stoffer i kosttilskudd og sporstoffer. Mer enn 40 kjemiske stoffer er inkludert i kunnskapsbasen.



Figur 1. En oversikt over kunnskapsbasen VKM har utarbeidet og de planlagte bruksområdene for Mattilsynet (i grønt).

Matvarer som er kjente bidragsytere til eksponering for et uønsket kjemisk stoff ble identifisert fra kvantitative og kvalitative data, hovedsakelig fra EFSA-uttalelser og VKM risikovurderinger. Fire nasjonale kostholdsundersøkelser ble brukt for å identifisere matvarer og matvaregrupper som vanligvis spises av den norske befolkningen. Denne informasjonen ble brukt til å identifisere potensielle ukjente kilder til eksponering for de ulike uønskede kjemiske stoffene. Informasjonen ble samlet i en kunnskapsbase bestående av 456 «uønsket kjemisk stoff/matvare»-par som ble identifisert som relevante for overvåking.

For hvert "uønsket kjemisk stoff/matvare" par, er følgende informasjon inkludert i kunnskapsbasen:

- Matvarekategori
- Bidrag til total eksponering, inkludert grad av bidrag
- Hvor forekomstdataene er fra (norske data, europeiske data), og hva som finnes av norske data
- Kommentarer til prøvetaking
- Hvordan det kjemiske stoffet havner i maten
- Risiko (en kombinert score for fare og eksponering)

Prøvetaking av mat er et komplekst område og det er nødvendig med nøye planlegging av prøvetakingsstrategien. Hvilke parametere som bør tas i betraktning ved planlegging av strategi for prøvetaking avhenger av egenskapene til det kjemiske stoffet og matvaren. I denne rapporten har VKM beskrevet generiske retningslinjer for prøvetakingsstrategi, inkludert prøvenummer og frekvens.

Abbreviations

AFLAs	Aflatoxins
Al	Aluminium
AME	Alternariol methyl ether
AOH	Alternariol
AZAs	Azaspiracids
BHT	Butylated hydroxytoluene
BPA	Bisphenol A
BPAF	Bisphenol AF
BPF	Bisphenol F
BPS	Bisphenol S
Cd	Cadmium
DL-PCBs	Dioxin-like PCBs
DON	Deoxynivalenol
ENNs	Enniatins
FUMs	Fumonisins
GEs	Glycidyl fatty acid esters
HAAs	Heterocyclic aromatic amines
HT2	HT-2 toxin
iAs	Inorganic arsenic
MCs	Microcystins
MCPD	Monochloropropane-1,2-diol
MeHg	Methyl mercury
NDL-PCBs	Non-dioxin-like PCBs
NFSA	Norwegian Food Safety Authority
OTA	Ochratoxin A
PAs	Pyrrolizidine alkaloids
PAHs	Polycyclic aromatic hydrocarbons
PAT	Patulin
Pb	Lead
PCBs	Polychlorinated biphenyls
PCDDs	Polychlorinated dibenzo-p-dioxins
PCDFs	Polychlorinated dibenzofurans
PFAS	Per- and polyfluoroalkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
POPs	Persistent organic pollutants
Sn	Tin
T2	T-2 toxin
TAs	Tropane alkaloids
TTX	Tetrodotoxin
VKM	Norwegian Scientific Committee for Food and Environment
ZEN	Zearalenone

Definitions used for the purpose of this report

Control plans
The aim of control plans is to specifically target food products or the most at-risk companies regarding the presence of undesirable chemical substances that may pose a health risk in the food chain or a given production sector.

Food
In the regulation (EC) No 178/2002, the following definition is given: *'Food' (or 'foodstuff') means any substance or product, whether processed, partially processed or unprocessed, intended to be, or reasonably expected to be ingested by humans. 'Food' includes drink, chewing gum and any substance, including water, intentionally incorporated into the food during its manufacture, preparation or treatment* (EC 1881/2006). For the purpose of this report, food supplements are also considered to be food.

Food supplement/dietary supplement
Food containing concentrated amounts of nutrients or other substances that are intended to supplement the normal diet (EFSA, 2020).

Habitually eaten food
Food items with highest intakes in different age groups.

Monitoring
Food monitoring is a system of repeated examination, measurement, and evaluation of levels of undesirable chemical substances, such as plant protection products, heavy metals and other contaminants.

Official controls
For the purposes of this report; "official controls" means activities performed by the competent authorities to verify compliance with regulations.

Undesirable chemical substances in food
For the purpose of this report, undesirable chemical substances in food are defined as chemical substances in food that may constitute a potential health risk, and are limited to unauthorised use levels of food additives, unauthorised substances, contaminants, natural toxins, processing contaminants and substances migrating from food contact materials.

Background as provided by the Norwegian Food Safety Authority

Foods shall not contain levels of undesirable substances that can be a health concern. An extensive overview of the occurrence of substances in foods contributes to ensure consumer safety and can be obtained by monitoring. To prioritize which substances to include in the monitoring of substances, the Norwegian Food Safety Authority (NFSA) asked the Norwegian Scientific Committee for Food and the Environment (VKM) in spring 2019 to provide a knowledge-based ranking of substances that may pose a potential health risk to the Norwegian consumers. The assignment was divided into three parts. Part 1; to provide an overview of undesirable substances in foods, drinks and dietary supplements that may potentially pose a health risk. Part 2; to assess and rank the substances identified in Part 1, according to potential health risks. Part 3; for each of the substances identified in Part 1, to describe a) which foods, drinks and/or dietary supplements are most relevant for monitoring and b) what is adequate sampling and number of samples to ensure monitoring that is representative for the occurrence in foods consumed by the Norwegian population.

NFSA received the report from VKM 16th September 2019. Parts 1 and 2 were comprehensively answered. Due to time restrictions given by NFSA, Part 3 was answered by expert judgment, and a systematic literature search was not performed. NFSA is now in need of a more comprehensive knowledge base regarding the foods that are relevant for monitoring with respect to the contaminants identified and ranked by VKM. In addition, NFSA requests more knowledge regarding sampling and number of samples. The new official control regulation (EU2017/625) obligates NFSA to submit and follow national control plans for contaminants in foods from 2023. NFSA therefore asks VKM to revisit and expand Part 3 of the previous assignment.

Terms of reference as provided by the Norwegian Food Safety Authority

Assignment:

a) For the substances identified in VKM's report "Ranking of substances for monitoring in foods, drinks and dietary supplements–based on risk and knowledge gaps (2019)", the NFSA asks VKM to give an overview of the food/part of the food (e.g. fat versus muscle), drinks and/or food supplements consumed by the Norwegian population (e.g. based on national dietary surveys), that are relevant for monitoring.
b) For each combination of substance and food/drink/food supplement in a), describe how sampling should be performed to
    - Obtain sufficient data on occurrence, levels, and status in Norway.
    - Be useful and relevant for exposure assessments of the Norwegian population (including vulnerable groups).

Factors that may be included in VKM's assessment of sampling (not an exhaustive list)

- Number of samples (representativity)
- Aggregate samples versus single samples
- Frequency of sampling
- Season/seasonal variations
- Geographical aspects
- Country of origin
- Preparations
- When relevant, other issues related to sampling*

*National authorities perform official controls according to regulation Forskrift om prøvetaking og analyse for offentlig kontroll av visse forurensende stoffer i næringsmidler covering the sampling, number of samples, and frequency of sampling for certain contaminants in foods. The purpose is to ensure that the foods are in compliance with the current regulations, i.e. that the foods do not exceed the existing maximum limits. The official controls do not, however, encompass sampling to ensure that data are representative for the occurrence of substances in the foods. Most data for official controls are not representative as they are taken risk-based, i.e. samples are taken in food where the risk of finding an exceedance of the maximum levels is high (to identify non-compliance).

1 Introduction

Monitoring should give data useful for achieving a representative description of the presence of undesirable chemical substances in food. In addition, the data obtained from monitoring should be useful for the assessment of potential risks associated with chronic exposure to undesirable chemical substances in food.

The overall aim of this project was to establish a comprehensive knowledge base useful as a tool to identify food groups and food items consumed by the Norwegian population that are relevant for monitoring regarding content of one or more undesirable chemical substances. Undesirable chemical substances were defined as chemical substances in food that may constitute a potential health risk.

The process behind the development of the knowledge base (an Excel file) is described in this report. An overview of the selection of undesirable chemical were described in the protocol (VKM et al., 2021) and in Chapter 2. The approaches applied to identify "undesirable chemical substance/food item" pairs included in the knowledge base were described in the protocol (VKM et al., 2021) and in Chapter 3 and 4. Information on food sampling is also included in the knowledge base, and more detailed descriptions are included in Chapter 5.

2 The chemical substances

In this chapter, the selection of the included undesirable chemical substances is described.

The substance groups included were delimited to flavourings, food additives, metals and metalloids, natural toxins, persistent organic pollutants (POPs), process-induced contaminants, substances in food contact materials, substances in food supplements and trace elements.

2.1 An overview of the included chemical substances

The following chemical substances, within the substance groups described above, were included (Table 2-1):

- Chemical substances/substance groups identified and ranked in the report "Ranking of substances for monitoring in foods, drinks and dietary supplements – based on risk and knowledge gaps (VKM et al. (2019). Only the chemical substances with a score for risk of 4 or higher were included. Substances scored 4 or higher for risk (the combined score for toxicity and exposure; on a scale where 2 was the lowest risk and 6 was the highest risk) are considered likely to have a higher risk of causing negative health effects than substances with lower scores. An overview is given in Appendix A.

AND

- Contaminants included in the Commission Regulation for certain contaminants in foodstuffs (EC 1881/2006). Maximum levels for certain contaminants in foodstuffs are set to keep content of the contaminants at levels which are toxicologically acceptable to protect public health. All contaminants in the regulation were included as NFSA needs to consider these substances for the development of control plans. An overview is given in Appendix B.

Exceptions from the above points:

- Ethoxyquin, scored 4 in VKM et al. (2019), is not included due to the suspended authorisation as a feed additive for all animal species.
- Curcumin, docosahexaenoic acid and lycopene used as food additives, all scored 4 in VKM et al. (2019), are less relevant to monitor as they are included in the Norwegian positive lists for «other substances» (Lovdata, 2019) and are therefore not included in this report.

Table 2-1. An overview of the substance groups and the chemical substances included.

Substance group	Subgroup	Substance
Flavourings and food additives		Caffeine
	Nitrites and nitrates	Sodium and potassium salts of nitrite and nitrate
	Phosphates	Phosphoric acid-phosphates
	Synthetic antioxidants	Butylated hydroxytoluene
Metals and metalloids		Aluminium
		Inorganic Arsenic
		Cadmium
		Lead
		Methylmercury
		Tin
Natural toxins	Mycotoxins	Aflatoxins
		Alternariol and Alternariol methyl ether
		Citrinin
		Deoxynivalenol and modified forms
		Enniatins
		Ergot sclerotia and ergot alkaloids
		Fumonisins
		Ochratoxin A
		Patulin
		T-2 and HT-2 toxins and modified forms
		Zearalenone and modified forms
	Plant toxins	Solanine and Chaconine
		Cyanogenic glucosides
		Erucic acid
		Pyrrolizidine alkaloids
		Tropane alkaloids
	Marine algae toxins	Azaspiracids
		Tetrodotoxin and analogues
	Freshwater algae toxins	Microcystins
Persistent organic pollutants	Dioxins and dioxin-like polychlorinated biphenyls	Dioxins and Dioxin-like polychlorinated biphenyls
	Non-dioxin-like polychlorinated biphenyls	Non-dioxin-like polychlorinated biphenyls
	Perfluorinated and polyfluorinated alkyl substances	Perfluorooctane sulfonate, Perfluorooctanoic acid
		Perfluorohexane sulfonic acid, Perfluorononanoic acid, Perfluorodecanoic acid, Perfluoroundecanoic acid and Perfluoroheptane sulfonate
		Perchlorate
Process-induced contaminants		Acrylamide
		3-Monochloropropane-1,2-dioland its fatty acid esters

Substance group	Subgroup	Substance
	Esterified 3- and 2-Monochloropropane-1,2-diol and Glycidyl esters	Glycidyl fatty acid esters
	Furans	Furan, 2-Methylfuran and 3-Methylfuran
	Heterocyclic aromatic amines	2-Amino-1-methyl-6-phenylimidazo[4,5-*b*]pyridine
		HAAs in general
	Polycyclic aromatic hydrocarbons	Polycyclic aromatic hydrocarbons in general were included in the VKM ranking report (2019). Benzo(a)pyrene, Benz(a)anthracene, Benzo(b)fluoranthene, and Chrysene are included in the regulation.
Substances in food contact materials	Bisphenols	Bisphenol S, Bisphenol F and Bisphenol AF
		Melamine
Trace elements		Iodine

2.2 Descriptions of the substance groups

2.2.1 Flavourings and food additives

There are several dietary **caffeine** sources, including caffeine-containing soft drinks, coffee and coffee-containing drinks, cocoa-containing products, and food supplements.

Sodium and potassium salts of nitrite and nitrate are commonly used as food additives in e.g. meat to prevent bacterial growth and to achieve desirable reddish colours. Nitrate is found naturally in some foods, e.g. spinach, and may also enter the food chain from contamination of water. Nitrate and nitrite are also authorised as an additive in feed.

Phosphoric acid-phosphates (di-,tri- and polyphosphates) are food additives that also may be found naturally occurring in foodstuffs.

Butylated hydroxytoluene (BHT) is authorised as an additive in food and used as an antioxidant in fats and oils and in many processed foods such as soups, sauces, breakfast cereals and fine bakery wares. BHT is also authorised as an additive in feed.

2.2.2 Metals and metalloids

Aluminium (Al) sulphates and sodium aluminium phosphates are registered food additives in baking powder and anti-caking agents. Al may be present in food due to its use as a food additive, as a contaminant leaching from packaging and cookware material to acidic food, and by uptake from soil into plants.

Arsenic (As) is a metalloid that occurs in different chemical forms in the environment and in food such as fish and seafood. Environmental sources of arsenic are natural and anthropogenic. **Inorganic arsenic (iAs)** forms are trivalent arsenite and pentavalent arsenate.

Cadmium (Cd) occurs naturally together with zinc and lead in minerals and can vary considerably among soil types. Anthropogenic sources to cadmium in soil are phosphate fertilisers and deposition from the atmosphere and sewage sludge.

Lead (Pb) is in soil both from natural geological sources and from anthropogenic activity.

Environmental sources of mercury are both natural and anthropogenic. **Methylmercury (MeHg)** is the most prevalent of the organic forms.

Tin (Sn) has been extensively employed for inside as well as outside coating of food cans for packaging and preservation of various foods.

2.2.3 Natural toxins

2.2.3.1 Subgroup mycotoxins

Many mycotoxins are frequently produced during storage; thus, appropriate storage conditions are important. The production of toxins on the field is largely dependent on the weather and is more difficult to control, but good agricultural practices may reduce infection rate and fungal growth.

Occurrence of mycotoxins in grain-derived foods in the Norwegian diet is dependent on the weather in the year of harvest, the percentage of imported grain, and the origin of the imported grain. The percentage of imported grain varies largely between years.

Mycotoxins are generally heterogeneously distributed. Efficient control of mycotoxins is therefore dependent on strategies for representative sampling.

Aflatoxins (AFLAs) are produced by *A. parasiticus* and *A. flavus*, both commonly found in areas with hot and humid climates and can occur in food as a result of fungal contamination in a range of food, feed or their ingredients before or after harvest. AFLAs are not produced in a Norwegian climate and the occurrence is restricted to imported food, feed, and ingredients. The geographical areas for AFLA production seem to spread further north in recent years and are now commonly found in cereals including maize grown in southern Europe. Efficient control of aflatoxins is difficult due to very heterogenous distribution patterns.

Alternariol (AOH) and **alternariol methyl ether (AME)** are produced on pre- and post-harvest crops by *Alternaria alternata*. High relative humidity in summer may lead to AOH and AME contamination in many types of food. *Alternaria* appeared to have an inverse correlation

with *Fusarium* fungi in Norwegian grain. Human exposure from vegetables is limited by the visible occurrence of *Alternaria* in many products, however, processed foods like canned tomatoes have been reported as a major source in other countries.

Citrinin is produced by different species of *Aspergillus, Penicillium* and *Monascus*, and can contaminate a wide range of foods and feeds mainly post-harvest, but also during the pre-harvest and harvest. Citrinin decomposes during heating and produce both more and less cytotoxic metabolites, thus, heat-treatment may affect monitoring results.

Deoxynivalenol (DON) is primarily produced pre-harvest by *Fusarium* fungi, occurring predominantly in cereal grains. DON and modified forms are among the most common mycotoxins in Norwegian-grown cereals as well as in most wheat-exporting countries. The occurrence of DON and other fusarium toxins is largely dependent on weather conditions and large annual and geographical variations are to be expected.

Enniatins (ENNs) are secondary fungal metabolites that are mainly produced pre-harvest by *Fusarium* species, and in particular *F. avenaceum*. ENNs belong to the most frequently occurring contaminants in grain and grain-based products and the concentrations may be high.

Ergot sclerotia and **ergot alkaloids** are mainly produced by *Claviceps* species. In Europe, *Claviceps purpurea* is the most widespread species, and it commonly infects grass species including cereals such as rye, wheat, triticale, barley, sorghum, millets, and oats. Highest levels of *Claviceps* are generally found in rye.

Fumonisins (FUMs) are primarily produced by *Fusarium verticillioides* and *Fusarium proliferatum*. FUMs occur predominantly in cereal grains, especially in maize.

Ochratoxin A (OTA) is a storage mycotoxin produced by *Aspergillus* and *Penicillium* in both tropical and temperate regions, mainly under humid conditions. OTA may occur in a large variety of food products stored under suboptimal conditions. Normally the levels are low, but high levels may occur in batches stored under suboptimal conditions.

Patulin (PAT) is produced by a wide range of *Penicillium* and *Aspergillus* species, of which *P. expansum*, a common contaminant of damaged fruit, such as apples, is the most important. Apple products are considered the main dietary source of intake for patulin.

T-2 toxin (T2) and **HT-2 toxin (HT2)** are produced by various *Fusarium* species and occur in all major wheat-, barley- and oat-producing parts of the world. T2 and HT2 are normally found in higher concentrations in oats than in other grains. It is a large annual variation in the occurrence of T2 and HT2 due to weather conditions. The tolerable daily intake for the sum of T-2 and HT-2 toxins is low and a dedicated analytical method may be needed for providing data for exposure assessments.

Zearalenone (ZEN) is produced by several *Fusarium* species, particularly *Fusarium graminearum*. ZEN occurs worldwide in all types of grains, but the highest concentrations are

generally found in maize. Dietary exposure in Norway has therefore been low due to low maize consumption.

2.2.3.2 Subgroup plant toxins

Pyrrolizidine alkaloids (PAs) are a large group of natural toxins synthesised as secondary metabolites by different plant species. PAs occur in e.g. herbal tea and herbal infusions, honey and food supplements (plant extracts and pollen-based supplements) which has been implicated in episodes of human intoxications. PAs may also enter food and feed chain through alkaloid-containing weed. In Norway only one species, Ragworth (*Senecio jacobaea*), is known to be involved in poisonings of grazing animals. In recent years, also other PA-producing plants such as South-African ragworth (*Senecio inaequidens*) have been found in Norway, but so far, the geographical distribution has been limited.

The glycoalkaloids **solanine and chaconine** are produced in potatoes and are also found in eggplants, apples, bell peppers, cherries, sugar beets, chili, and tomatoes. The concentration varies with potato sort and growing, harvesting, and storage conditions. Increasing levels are found in potatoes exposed to light, insect-damaged potatoes or after mechanical damages.

Tropane alkaloids (TAs) are toxic secondary metabolites occurring in plants from several plant families including *Brassicaceae*, *Solanaceae* and *Erythroxylaceae* (including cocoa), which occur in all parts of the plant. Human intoxications have been reported from consumption of flour contaminated with seeds from TA-producing species, normally from the genus *Datura* or from consumption of TA-containing plants mistaken for edible plants or seeds.

Erucic acid is present in the oil-rich seeds of the *Brassicaceae* family, particularly in rapeseed and mustard. Erucic acid is also found in the marine food web and seafood is a major contributor, in particular fatty fish.

Foods such as apricot kernels, almonds, linseeds, bamboo, and cassava contain **cyanogenic glycosides**. The amount that is released is dependent on the food source and processing.

2.2.3.3 Subgroup marine algae toxins

Azaspiracids (AZAs) are regularly reported to be present in shellfish along the coast of Norway, and blue mussels are therefore included in the surveillance of algal toxins. Crabs may also contain AZAs.

Tetrodotoxin (TTX) has traditionally been associated with seafood from tropical regions. However, TTX has been detected in bivalve molluscs in more temperate European waters, i.e. in the UK and the Netherlands.

2.2.3.4 Subgroup freshwater algae toxins

Microcystins (MCs) are produced by various cyanobacteria. Human exposure from food can be due to consumption of fish, crabs, mussels, crops, food supplements based on algae or items of animal origin, following the use of contaminated water for irrigation or in farming activities.

2.2.4 Persistent organic pollutants (POPs)

Time-trends are needed to gain knowledge on the effect of measures to reduce the content the level of POPs in food.

Dioxins and dioxin-like polychlorinated biphenyls (DL-PCBs) are a group of persistent, lipid soluble and highly toxic organic pollutants that accumulate in the food chain.

Non-dioxin-like polychlorinated biphenyls (NDL-PCBs) are persistent and highly fat soluble and accumulate in the food chain.

Per- and polyfluoroalkyl substances (PFAS) are a group of man-made chemicals that includes perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), and many other similar chemicals. PFAS are manufactured and used in a variety of consumer and industrial products around the globe. PFOA and PFOS have been the most extensively produced and both are persistent in the environment, in the human body, and accumulate in the food chain.

Perchlorate is a contaminant naturally present in the environment and because of human activity. The use of natural fertilisers and perchlorate-contaminated irrigation water may lead to substantial concentrations in leafy vegetables.

2.2.5 Process-induced contaminants

Acrylamide is a low molecular weight, water-soluble organic chemical formed in carbohydrate-rich foods from naturally present carbohydrates (reducing sugars) and amino acids (asparagine) during cooking or other heat-processing. Formation depends on a variety of factors, such as temperature, time, and amount of sugar/starch in the raw material. For potatoes, seasonal variation is expected concerning the content of sugar. Washing of the raw material before heat-treatment have shown to be effective.

Esterified 3- and 2-monochloropropane-1,2-diol (MCPD) and glycidol esters (GEs) are contaminants of processed vegetable oils, and free MCPDs are formed in some processed foods. GEs are formed during high temperature processing of fats and oils (200°C) and is converted to glycidol following ingestion.

Furan is a volatile and lipophilic compound formed in a variety of heat-treated commercial foods and contributes to the sensory properties of the product. Furan has been found in several foods such as coffee, and canned and jarred foods, including baby food containing

meat, and various vegetables. The occurrence of furan in a variety of foods suggests that there are multiple routes of furan formation rather than a single mechanism.

Heterocyclic aromatic amines (HAAs) are heat-induced food toxicants. The main source of human exposure to HAAs cooked proteinaceous foods; however, the levels of HAAs are highly dependent on the type of meat, cooking time and cooking temperature, and generally increase with the level of «doneness».

Polycyclic aromatic hydrocarbons (PAHs) are a large group of chemicals consisting of two or more fused aromatic rings, and several hundred PAHs have been described. In unprocessed foods, levels of PAH reflect the environmental contamination. Processing of food such as drying and smoking and cooking of foods at high temperatures (grilling, roasting, frying) are major sources generating PAH.

2.2.6 Substances in food contact materials

Substances in food contact materials may migrate into the foods. **Bisphenols** are present in polycarbonate plastics and epoxy resins used as food packaging. **Melamine** plastic is used for making food contact materials for repeated use (i.e. tableware). The presence of the bisphenols and melamine in food depends on the type of material used and the character of the food contact. Factors such as temperature and acidity may affect the migration of bisphenols and melamine from the food contact material to food.

2.2.7 Substances in food supplements

A wide range of different food supplements exists, and the supplements can contain different toxicants based on the ingredients. Reports of deaths and cancer have been reported in cases where toxic plant ingredients have been confused with non-toxic plant ingredients. However, this is not addressed in this report, neither are pharmaceuticals or pesticides.

For the included substances in this report, the relevant "undesirable chemical substance/food supplement" pairs to monitor have been added to the knowledge base.

2.2.8 Trace elements

Iodine has been highlighted due to the risk of very high occurrence in supplements and foods made from macro-algae.

3 Identification of food groups/food items habitually eaten

Food groups/food items habitually eaten were used to identify potential unknown food sources of undesirable chemical substances.

The four most recent national dietary surveys for adults (Norkost 3), children and adolescents (Ungkost 3), toddlers (Småbarnskost 3) and infants (Spedbarnskost 3) are part of the national dietary surveillance system in Norway. These four surveys were used for the description of the habitual diet in the Norwegian population. An overview of the surveys is given in Table 3-1.

Table 3-1. The Norwegian national food consumption surveys used for the description of habitual diet in different age groups.

Study	Year of data collection	Age groups (years)	Participants (number)	Participation rate (%)	Method used
Spedkost 3	2019	1	1957	66	Web-based or paper-based (optional) food frequency questionnaire
Småbarnskost 3	2019	2	1413	47	Web-based or paper-based (optional) food frequency questionnaire
Ungkost 3	2015/2016	4	399	20	Web-based food diary
		8-9	636	55	
		12-13	687	53	
Norkost 3	2010-2011	18-70	1787	37	Two 24-hour recalls by telephone
			1453	30	Food propensity questionnaire

3.1 The national dietary surveys

3.1.1 Spedkost 3 and Småbarnskost 3

The national dietary surveys Spedkost 3 (1-year-olds) and Småbarnskost 3 (2-year-olds) were conducted by the University of Oslo in collaboration with the Norwegian Institute of Public Health (Astrup et al., 2020; Paulsen et al., 2020). The data collection period was March to May 2019 for Spedkost 3 and February to April 2019 for Småbarnskost 3. The surveys used a semi-quantitative food frequency questionnaire (FFQ) for the assessment of diet. The caregivers were asked to have the last two weeks of food intake in mind, when filling in the questionnaire. The questionnaires had approximately 180 food frequency

questions. Food portion sizes were estimated using photographs and predefined household units. A total of 1957 1-year-olds and 1413 2-year-olds participated, which gave participation rates of 66% and 47%, respectively.

3.1.2 Ungkost 3

The national dietary survey Ungkost 3 (4-, 9- and 13-year-olds) was conducted by the University of Oslo, in collaboration with the Norwegian Directorate of Health and the Norwegian Institute of Public Health (Hansen et al., 2015). The data was collected during autumn 2015 for 9- and 13-year-olds, and spring 2016 for 4-year-olds. The food intake in Ungkost 3 was assessed using a validated web-based four-day food record (Medin et al., 2015; Medin et al., 2016; Medin et al., 2017). The web food record used a food database of approximately 570 of the most often consumed foods and beverages in Norway. The web food record was structured around meals, with photographs to estimate portion sizes, and with the possibility to enter food items not found in the food lists in the program in an open text field. A total of 399 4-year-olds, 636 9-year-olds and 687 13-year-olds participated in the survey. The participation rates were 20%, 55% and 53%, respectively.

3.1.3 Norkost 3

The national dietary survey Norkost 3 was conducted by the University of Oslo in collaboration with the Norwegian Directorate of Health. Norkost 3 assessed diet using two 24-hour recall interviews conducted over the telephone at least one month apart. Food amounts were presented in household measures or estimated from photographs (Totland et al., 2012). The study was conducted in 2010/2011, and 1787 men and women aged 18-70 years participated with two days of recording.

3.2 Calculation of the reported dietary intake

The food composition and dietary assessment system KBS, at the University of Oslo, was used to calculate the reported intake of food groups in the different age groups. The KBS food composition database is an extended version of the Norwegian food composition table (www.matvaretabellen.no). KBS includes several food composition database versions compiled and updated regularly. The AE18 database in KBS was used for all calculations, except for the calculations conducted on the Norkost-data (adults), where the N3-database was used.

Main food group categories and subgroups of foods within each of the main food categories were calculated for the following age groups, not stratified by sex:

- Children 1 year
- Children 2 years
- Children 4 years
- Children 9 years

- Adolescents 13 years
- Women 18-45 years (of childbearing age)
- Adults 18-70 years

The definition of the main food categories and subgroups are the standard built-in food categories in KBS. All main food categories in KBS and their corresponding subcategories are included in the calculations. The reported intake (assumed consumed intake) from the different food categories was calculated as mean grams per day at group level, and as a percentage of the total intake. The percentage of consumers within a food category was also calculated for all food groups.

A group of heterogeneous miscellaneous food items (categorised as miscellaneous in KBS), that combined contributed with 0.3-3.2% of the total intake in the different age groups, was excluded from the tables, as the contribution of the individual food items was considered negligible.

3.3 The habitual diet

In tables 3.3-1 to 3.3-7, the main food group categories are shown for the different age groups. Rows in **yellow** color show food categories consumed by at least 90% of the participants, and that independently contribute with at least 5% to the total intake. Rows in **blue** color show food categories consumed by at least 90% that independently contribute with less than 5% to the total intake. Rows in **white** color show food categories consumed by less than 90% and contribute with less than 5% to the total intake. The **red** line shows where the added contribution of each category has reached at least 90% of the total intake.

The subgroups of foods within each of the main food categories are presented in Appendix C (Tables C-1 to C-7).

Table 3.3-1. Main food groups from Spedkost 3 that are consumed by 1-year-olds, ranked in descending order by intake in grams/day on average at group level (n = 1957; numbers are rounded).

Main food categories	***Main food categories in Norwegian***	**g/day**	**% of total intake**	**Cumulative %***	**Consumers %**
Infant foods	*Spedbarnsmat*	724	51	51	100
Beverages	*Drikkevarer*	284	20	71	100
Milk and dairy products**	*Melk og meieriprodukter***	96	7	78	92
Fruits and berries	*Frukt og bær*	77	5	83	98
Bread	*Brød*	66	5	88	98
Vegetables	*Grønnsaker*	64	5	92	98
Meat and offal	*Kjøtt og innmat*	26	2	94	99
Fish and seafood	*Fisk og sjømat*	18	1	95	95

Main food categories	*Main food categories in Norwegian*	g/day	% of total intake	Cumulative %*	Consumers %
Potato and potato products	*Poteter og potetprodukter*	16	1	97	82
Other grain products***	*Andre kornprodukter****	12	0,9	97	92
Butter, margarine, and oils	*Smør, margarin og olje*	10	0,7	98	99
Cheese	*Ost*	10	0,7	99	89
Eggs	*Egg*	9	0,6	99	86
Sweet baked goods	*Søte bakverk*	3	0,2	100	68
Sugar and sweets	*Sukker og søtsaker*	0,3	0,02	100	17

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products, not including butter and cheese.
*** Cereals, rice, corn products, biscuits, not including cakes and cookies.

Table 3.3-2. Main food groups from Småbarnskost 3 that are consumed by 2-year-olds, ranked in descending order by intake in grams/day on average at group level (n = 1413; numbers are rounded).

Main food categories	*Main food categories in Norwegian*	g/day	% of total intake	Cumulative %*	Consumers %
Beverages	*Drikkevarer*	563	33	33	100
Milk and dairy products**	*Melk og meieriprodukter***	424	24	57	99
Infant foods	*Spedbarnsmat*	205	12	69	97
Fruits and berries	*Frukt og bær*	162	9	78	100
Bread	*Brød*	113	7	85	100
Vegetables	*Grønnsaker*	86	5	90	100
Meat and offal	*Kjøtt og innmat*	37	2	92	100
Fish and seafood	*Fisk og sjømat*	28	2	94	99
Other grain products***	*Andre kornprodukter****	26	1	95	100
Cheese	*Ost*	21	1	96	99
Butter, margarine and oils	*Smør, margarin og olje*	19	1	97	100
Potato and potato products	*Poteter og potetprodukter*	16	0,9	98	81
Eggs	*Egg*	12	0,7	99	97

Main food categories	*Main food categories in Norwegian*	g/day	% of total intake	Cumulative %*	Consumers %
Sweet baked goods	*Søte bakverk*	8	0,5	99	95
Sugar, sweets	*Sukker og søtsaker*	4	0,2	100	83

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products, not including butter and cheese.
*** Cereals, rice, corn products, biscuits, not including cakes and cookies.

Table 3.3-3. Main food groups that are consumed by 4-year-olds, Ungkost3, ranked in descending order by intake in grams/day on average at group level (n = 399; numbers are rounded).

Main food categories	*Main food categories in Norwegian*	g/day	% of total intake	Cumulative %*	Consumers %
Beverages	Drikkevarer	439	31	31	100
Milk and dairy products**	Melk og meieriprodukter**	313	22	53	99
Fruit, berries	Frukt og bær	191	13	66	100
Bread	Brød	118	8	74	100
Other grain products***	Andre korn-produkter***	93	7	81	98
Vegetables	Grønnsaker	67	5	86	99
Meat and offal	Kjøtt og innmat	60	4	90	99
Cheese	Ost	31	2	92	97
Fish and seafood	Fisk og sjømat	31	2	94	85
Sweet baked goods	Søte bakverk	24	2	96	71
Potato and potato products	Poteter og potetprodukter	21	1	97	69
Sugar, sweets	Sukker og søtsaker	14	1	98	83
Eggs	Egg	12	1	99	54
Butter, margarine and oils	Smør, margarin og olje	11	1	100	97

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products, not including butter and cheese.
*** Cereals, rice, corn products, biscuits, not including cakes and cookies.

Table 3.3-4. Main food groups that are consumed by 8-9-year-olds, Ungkost 3, ranked in descending order by intake in grams/day on average at group level (n = 636; numbers are rounded).

Main food categories	*Main food categories in Norwegian*	g/day	% of total intake	Cumulative %*	Consumers %

Beverages	*Drikkevarer*	575	34	34	100
Milk and dairy products**	*Melk og meieriprodukter***	330	20	54	99
Fruit and berries	*Frukt og bær*	159	9	63	95
Bread	*Brød*	156	9	73	100
Other grain products***	*Andre kornprodukter****	98	6	79	96
Meat and offal	*Kjøtt og innmat*	96	6	84	100
Vegetables	*Grønnsaker*	81	5	89	97
Sweet baked goods	*Søte bakverk*	37	2	91	73
Potato and potato products	*Poteter og potetprodukter*	36	2	94	70
Cheese	*Ost*	35	2	96	95
Sugar and sweets	*Sukker og søtsaker*	29	2	97	86
Fish and seafood	*Fisk og sjømat*	22	1	99	63
Butter, margarine, oils	*Smør, margarin og olje*	12	1	99	91
Eggs	*Egg*	12	1	100	43

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products, not including butter and cheese.
*** Cereals, rice, corn products, biscuits, not including cakes and cookies.

Table 3.3-5. Main food groups that are consumed by 12-13-year-olds, Ungkost3, ranked in descending order by intake in grams/day on average at group level (n = 687; numbers are rounded).

Main food categories	***Main food categories in Norwegian***	**g/day**	**% of total intake**	**Cumulative %***	**Consumers %**
Beverages	*Drikkevarer*	712	39	39	100
Milk and dairy products**	*Melk og meieriprodukter***	304	17	56	95
Bread	*Brød*	169	9	65	100
Fruit and berries	*Frukt og bær*	149	8	73	89
Meat and offal	*Kjøtt og innmat*	113	6	79	99
Other grain products***	*Andre kornprodukter****	91	5	84	94
Vegetables	*Grønnsaker*	87	5	89	96

Potato and potato products	*Poteter og potetprodukter*	39	2	91	69
Sugar and sweets	*Sukker og søtsaker*	38	2	93	82
Cheese	*Ost*	38	2	95	94
Sweet baked goods	*Søte bakverk*	36	2	97	65
Fish and seafood	*Fisk og sjømat*	22	1	99	52
Butter, margarine, oils	*Smør, margarin og olje*	13	1	99	89
Eggs	*Egg*	12	1	100	39

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products, not including butter and cheese.
*** Cereals, rice, corn products, biscuits, not including cakes and cookies.

Table 3.3-6. Main food groups from Norkost 3 that are consumed by women between 18-45 years, ranked in descending order by intake in grams/day on average at group level (n = 435; numbers are rounded).

Main food categories	***Main food categories in Norwegian***	**g/day**	**% of total intake**	**Cumulative %***	**Consumers %**
Beverages	*Drikkevarer*	2112	59	59	100
Fruits and berries	*Frukt og bær*	287	8	67	95
Milk and dairy products**	*Melk og meieriprodukter***	286	8	75	94
Vegetables	*Grønnsaker*	142	4	79	98
Bread	*Brød*	140	4	83	99
Meat and offal	*Kjøtt og innmat*	117	3	86	97
Other grain products***	*Andre kornprodukter****	70	2	88	89
Potato and potato products	*Poteter og potetprodukter*	44	1	89	55
Fish and seafood	*Fisk og sjømat*	44	1	90	54
Cheese	*Ost*	39	1	91	88
Sweet baked goods	*Søte bakverk*	30	0,8	92	49
Butter, margarine and oils	*Smør, margarin og olje*	23	0,6	93	97

Main food categories	*Main food categories in Norwegian*	g/day	% of total intake	Cumulative %*	Consumers %
Sugar and sweets	*Sukker og søtsaker*	21	0,6	94	92
Eggs	*Egg*	19	0,5	94	44

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products, not including butter and cheese.
*** Cereals, rice, corn products, biscuits, not including cakes and cookies.

Table 3.3-7. Main food groups from Norkost 3 that are consumed by adults between 18-70 years, ranked in descending order by intake in grams/day on average at group level (n = 1787; numbers are rounded).

Main food categories	*Main food categories in Norwegian*	g/day	% of total intake	Cumulative %*	Consumers, in percent
Beverages	*Drikkevarer*	2137	58	58	100
Milk and dairy products*	*Melk og meieriprodukter**	334	9	67	94
Fruits and berries	*Frukt og bær*	285	8	75	94
Bread	*Brød*	171	5	80	99
Vegetables	*Grønnsaker*	147	4	84	97
Meat and offal	*Kjøtt og innmat*	143	4	88	97
Other grain products**	*Andre kornprodukter***	68	2	89	84
Fish and seafood	*Fisk og sjømat*	67	2	91	65
Potato and potato products	*Poteter og potetprodukter*	66	2	93	66
Cheese	*Ost*	39	1	94	87
Sweet baked goods	*Søte bakverk*	35	0,9	95	51
Butter, margarine and oils	*Smør, margarin og olje*	31	0,8	96	98
Eggs	*Egg*	25	0,7	97	49
Sugar, sweets	*Sukker og søtsaker*	18	0,5	97	85

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products, not including butter and cheese.
*** Cereals, rice, corn products, biscuits, not including cakes and cookies.

4 Identification of "undesirable chemical substance/food item" pairs relevant to monitor

The overview of food items contributing to the total exposure to a chemical substance is based on quantitative and qualitative data from EFSA opinions and VKM risk assessments. In addition, expert judgement was applied to identify potential "unknown" contributors. Descriptions of the data, the terms used to categorise the contribution to the total exposure from a given "undesirable chemical substance/food item" pair, and the prioritisation of the data, are given in Table 4-1. For each chemical substance, an overview of the data used to establish the knowledge base is given in Appendix D.

Data were included into the knowledge base in a prioritised order (Table 4-1), and quantitative data were given higher priority than qualitative data. When data of a higher priority were identified, data of a lower priority were not included. For the quantitative data, the following choices were made regarding inclusion in the knowledge base:

- When the contribution from a food item/food group was <1%, the "undesirable chemical substance/food item" pair was not included in the knowledge base.
- Data on contribution to total exposure based on lower bound estimates were used when available. Lower bound estimates are calculated by setting analytical results below the limit of detection or limit of quantification of the analytical method to zero.
- When data on contribution of a food item/food group to the total exposure to a given chemical substance were available for different age groups, the highest reported contribution was used.
- When data on contribution of a food item/food group to the total exposure to a given chemical substance were available for different age groups, data for infants, toddlers, children, adolescents, and adults were considered for inclusion. Data on contribution of a food/item/food for the age groups "elderly" and "very elderly" were not considered for inclusion.
- When contribution of a food item/food group to total exposure were given both as minimum and maximum, the minimum contribution was used.
- When data on contribution of a food item/food group to the total exposure to a given chemical substance were reported as number of dietary surveys resulting in exposure in the following categories: <1%, 1-5%, 5-10%, 10-25% and 25-50%, the highest reported exposure category was used.
- When exposure estimates for different European countries were available, but not for Norway, a pragmatic solution considered as feasible was to use data from another Nordic country. As Danish data were available, these were used.

Expert judgement was applied to identify other possible, and maybe unknown, food sources for the exposure to a chemical substance. Food items with highest intakes in different age groups, called the "habitual diet" in this report, was used to identify other possible sources in combination with knowledge on the chemical properties of the substances. For natural toxins, favourable conditions for toxin production were also considered, whereas for the additives, knowledge on use in feed production was used to identify possible contributors as substances in feed may be carried over to food.

Table 4-1. Data included in the knowledge base (the Excel file) and the terms used to categorise the data.

Data / approaches	Description of data included in the knowledge base	Categorisation of contribution to exposure	Categorisation of the degree of contribution	Prioritisation of data (on a scale from 1 to 5; 1 has the highest priority)
Quantitative data	Data on the percent contribution of a food group/food item to the total exposure with a chemical substance were available. All food groups/food items with a contribution higher than 1% were included in the knowledge base.	Contributor	Very high (50-100%) High (25-<50%) Moderate (10-<25%) Low (1-<10%)	1
	Exposure assessment data were available. Percent contribution of a food group/food item to the total exposure to a chemical substance was estimated from the available exposure data. All food groups/food items with a contribution higher than 1% were included in the knowledge base. To make it clear that we have calculated the contribution as a percentage, an (E) is placed in parentheses behind the degree of contribution.	Contributor (E)	Very high (50-100%) High (25-<50%) Moderate (10-<25%) Low (1-<10%)	2
Qualitative data	Food group/item was described as a major contributor for the substance. All food groups/food items reported to be major contributors were included.	Contributor (M)	Not available	3
	"Undesirable chemical substance/food item" pairs identified by the French Agency for Food, Environmental and Occupational Health & Safety in their report "optimisation of the official monitoring and control plans on the chemical contamination of food at all stages of the food chain (excluding water and animal feed)" (ANSES, 2019). Inclusion is based on expert judgement. When data on occurrence in these food items were available, these were included in the column for comments.	Possible contributor	Not available	4

Data / approaches	Description of data included in the knowledge base	Categorisation of contribution to exposure	Categorisation of the degree of contribution	Prioritisation of data (on a scale from 1 to 5; 1 has the highest priority)
	Information was available that the food group/item could contain the substance. Inclusion was based on expert judgement. When data on occurrence in these food items were available, these were included in the column for comments.	Possible contributor (C)	Not available	5
The habitual diet/ expert judgement	Food groups that may contain the substance were identified using expert judgement and the habitual diet (Chapter 4). Applied to all included chemical substances. To make it clear that we have identified the "undesirable chemical substance/food item" pairs by expert judgement, and that it was limited to the habitual diet, and (H) is placed in parentheses behind the contribution.	Possible contributor (H)	Not available	Not applied

4.1 Norwegian occurrence data

The availability of Norwegian occurrence data for the included "undesirable chemical substance/food item" pairs was described in the knowledge base using a scale with three categories (Table 3.1-1).

Table 3.1-1. Categories used to describe the availability of Norwegian occurrence data.

Category	Description
A	The occurrence of the chemical substance in the food item/food group is regularly analysed.
B	The occurrence of the chemical substance in the food item/food group is sporadically analysed and data from 2017 or later were available.
C	Analyses of the occurrence of the chemical substance in the food item/food group from 2017 or later were not available.

4.2 Limitations and uncertainties

The knowledge base includes data available before April 2022. Below is the major identified delimitations, limitations and uncertainties connected to the information provided in the knowledge base.

Inclusion of relevant substances to monitor

The included undesirable chemical substances were delimited to contaminants in the regulation EC 1881/2006 and substances included in a previous VKM risk ranking report (VKM et al., 2019). There is a chance that relevant undesirable chemical substances, such as emerging contaminants, have been left out of the knowledge base.

Identification and categorisation of relevant "undesirable chemical substance/food item" pairs to monitor

Extensive literature searches have not been performed, thus, there is a chance that relevant "undesirable chemical substance/food item" pairs have not been included in the knowledge base.

Concerning the categorisation of the degree of contribution (i.e. very high, high, moderate, low), it is important to note that this is performed on the reported food category level. Thus, when the reported food category is at a more detailed level (e.g. beef) the degree of contribution will be lower comparing to food categories at a less detailed level (e.g. meat).

The identification of "undesirable chemical substance/food item" pairs are based on a combination of what we eat and the occurrence of the substance in the food item. What we eat are subject to change due to a wide range of factors (see the section "Habitual diet and food trends" further down). The concentration of a substance in a specific food item or raw

material is also subjected to change due to a variation of factors such as climate change, availability of raw material, and changes in food processing methods.

Habitual diet and food trends

Several factors drive human food choices, and consequently the habitual diet in Norway, and how it varies over time. These can be individual factors, interpersonal factors, or micro and macro-environmental factors that influence food choices indirectly. Aspects outside of the direct control of an individual consumer, for example the price of foods, food outlet density in a living area, war- or climate-induced food shortages or other changes in the food supply, and industry regulations or policies, influence diet (Stok et al., 2017). The habitual diet described in this report is based on data from the most recently available national dietary surveys in Norway. These surveys are covering age groups up to 70 years but have variable participation rates in the different age groups, which may compromise the external validity. Another limitation is that not all the surveys have been conducted in recent years; the oldest is the Norkost 3 survey from 2011, which does not cover the latest changes in the habitual diet that has occurred over the last decade. However, existing food availability data from Norway is updated and published annually in the report "Utviklingen i norsk kosthold" (Helsedirektoratet, 2021) and the Norwegian public health survey "Folkehelseundersøkelsen 2020" (Abel and Totland, 2021) report on recent food trends.

Among observed trends is an increased focus on sustainable diets, which includes reducing meat consumption and increasing interest in vegetarian diets, especially among women, young people, and highly educated individuals. New plant-based food products, marketed as alternatives to traditional animal-based food items, are becoming more popular. Some of these new products are heavily processed. Also, new products based on marine algae/seaweed have emerged on food markets lately. Norkost 4, a new ongoing national dietary survey covering the age group 18-80 years will add to this knowledge base and should be considered when results are available.

5 Sampling of food commodities

Monitoring can have different purposes, e.g. ensure that the foods are in compliance with the current regulations or to ensure that undesirable chemical substances are not present in food at levels that may adversely affect the health of the consumers.

All foods are biological material, and therefore exhibit natural variations in composition, including the content of undesirable chemical substances. This variability relates to factors such as season, geography, habitat, trophic level, cultivar, husbandry, climate, storage conditions, and exposure to environmental pollutants. Thus, the content of undesirable chemical substances will vary, both between foods and within foods. To take into account this variation, analyses should be done on typical samples of the habitual diet. Thus, sampling design is pivotal, and which factors to include when planning and conducting the sampling will vary depending on the food items in question.

When planning the sampling, care should be taken to collect information about all factors that may influence the content of substances in the food in question and incorporate this into the sampling strategy. Sampling of food is a complex and demanding field requiring expertise and insight into the pitfalls that might affect the analytical outcome for the sample. Obtaining unbiased representative samples from a larger population of objects is difficult, but it can be done if the sampling is well planned and properly designed. In this chapter, generic considerations concerning the planning phase (Chapter 5.1), the sampling and analytical phase (Chapter 5.2) and the review and reporting phase (Chapter 5.3) are provided.

Remarks on sampling for specific "undesirable chemical substance/food item" pairs are given in the knowledge base (Excel file).

5.1 Planning phase – design and statistical considerations

An important consideration in the design of a surveillance program is compliance with good statistical practice. This includes specifying the target population of food objects under study and making a specific question to be answered by the survey. As advised by Milanzi et al. (2015), a clear definition of the population should be stated since this will affect the number of objects needed to obtain a representative sample. For example, in a monitoring study of persistent organic pollutants in fatty fish the population can for example be defined as "all the fatty fish available for consumption" in the country in a specific year, or "all the fatty fish from North Sea catches" available for consumption in the country in a specific year. The sizes of these two populations would clearly be different and lead to different sample sizes necessary to obtain a representative sample. Moreover, a specific research question should be stated depending on the objective for the survey. For example, the objective could be descriptive; "to describe the variation of dioxins and dioxin-like PCBs in muscle tissue of fatty fish from North Sea catches", or to test the hypothesis that "muscle tissue of fatty fish from North Sea catches does not exceed the regulatory maximum level for dioxin and dioxin-like

PCBs". The former would be a quantitative description of the fatty fish population only requiring enough samples to estimate the variation, while the latter would require a statistical power test to help establish the required sample size needed to correctly reject the null hypothesis.

Several different sampling designs are possible to obtain representative data. On commission by EFSA, Milanzi et al. (2015) proposed several sampling designs for food monitoring: "Simple random sampling", "Cluster sampling", "Stratified sampling" and "Designs for measuring changes over time". Choice of sampling design will also affect sample size calculations and an "R"-based software has been developed on commission by EFSA to calculate sample size for these designs (Verbeke and Varewyck, 2016). Expert advice in statistics should be part of the planning phase of a surveillance program.

5.1.1 Single versus pooled samples

To map the distribution and levels of undesirable chemical substances in food, single food samples should be analysed. This is especially important when the sources of undesirable chemical substances in a diet are known. Single sample analyses should, when the dietary sources are known, be prioritised enabling identification of variation, between and within specific food groups or food items. When the sources of undesirable chemical substances in the diet are unknown, the sampling strategy should focus on pooled samples, for the identification of main sources. For food items with a heterogenous distribution of the contaminants (e.g. mycotoxins), pooled (aggregate) samples should be used.

5.1.2 Selection of food samples

When planning the sampling, care should be taken to collect information about all factors that may influence the content of substances in the food in question and incorporate this into the sampling design. The samples should be representative for the main product on the market; thus, information on market shares should be included in the planning. Identifying market shares and incorporating this into the sampling strategy based on the main brands on the market is especially important for retail sampling. Bulk commodities from international shipments may be better sampled before processing (e.g. mycotoxins in wheat shipments) whereas if monitoring process-induced contaminants, sampling should be done in the processed product at retail.

5.1.3 Geographic area

Because factors such as, but not limited to, climate, soil conditions, feed (animal-based foods) and airborne pollution may affect the presence and/or the concentrations of undesirable chemical substances in food. Thus, for all foods, both imported and domestic, geographical origin should be identified and incorporated into the sampling design.

5.1.4 Seasonal variation

Seasonal variation needs to be taken into consideration. Some food items are more prone to variation in content due to seasonal changes than others. For each specific food item data on seasonal variations must be compiled and included in the sampling plan. Plant foods and fish may be especially prone to seasonal variations, e.g. seasonal lipid deposition and depletion in fish related to spawning and/or migration may affect the level of lipid soluble contaminants. Therefore, collection of samples needs to be organised, in terms of timing and frequency, to include these variations. In case of compliance check, it is sufficient to perform sampling at the time of year when the concentration of the contaminant in the food is highest (if known). For crops/food items that are stored over time before reaching the market, samples must be taken from different time points during storage.

5.1.5 Selection of the part of a food item

In general, only the parts of the food that is eaten should be analysed.

5.1.6 Number of samples

It is necessary to include a high enough number of primary samples for robust and representative results. The number of samples required will differ considerably depending on the substances and size of the food commodity population. Information about the variability of a substance is thus needed for sample size calculations (Greenfield and Southgate, 2003). This can be obtained from previous analytical projects or from scientific literature. VKM emphasise the importance of always conducting sample size calculation based on prior knowledge. In the rare cases where no existing data is available and sample size calculations cannot be done, NFSA should consult with experts and literature in the field of analysis and food composition compiling (Greenfield and Southgate, 2003) for planning the necessary number of samples. If the results from such a sampling design show high variability (large standard deviations), further samples should be obtained.

5.1.7 Frequency of sampling

Frequency and time point of sampling is influenced by a range of factors such as, for example, but not limited to, seasonality, storage time, and changes in processing. It is important to gain insight, knowledge and experience into food item/group specific factors that may affect the frequency of sampling and incorporate this into each specific sampling design.

5.1.8 General comments

Because sampling and analyses of food is very resource demanding, planning and conducting food sampling should be done in such a way that the samples may be used not only for analyses of undesirable chemical substances but also for analyses of nutrient

composition. Including analyses of both in a sampling will be an advantage and maximise resource utilisation.

5.2 Sampling and analytical phase

There are several factors that may affect representativeness when sampling. It is important that samples that are taken are truly random, i.e. that all objects in the population have an equal chance of being sampled. This is sometimes difficult to achieve in practice, in particular for food commodities with a high distributional heterogeneity of the contaminant, e.g. mycotoxins in grain shipments. Nevertheless, the principles necessary for representative sampling remain the same. Strategies for such representative sampling are already in place, e.g. in the case of mycotoxins. Based on the size of the shipment, specified quantities of material are taken from various places distributed throughout the lot or sublot, and an aggregate sample is made by combining these (EC 401/2006). Other guidance documents and EU legislation and describe best sampling practices to ensure adequate sampling procedures, including how to prepare aggregate samples and how to choose the number of samples. For other food items not covered in regulations, sampling protocols should be developed that may identify possible causes of sources of bias leading to non-representative data.

The quality of sampling is critical since inadequate sampling plans will compromise the reliability of the results and impact the interpretation of the result. Among the great difficulties for designing reliable and representative sampling approaches is the great diversity in possible inspection interventions, food sources, and types and degrees of food contaminations. It is therefore difficult to make specific recommendations on how to treat samples prior to analysis. However, some general considerations can be made. After sampling, samples must be stored in a suitable container that will not affect the analytical result, e.g. aluminum foil should not be used when analysing for metals, nor should plastic containers made of the specific plastic component of interest be used when analysing for plastic components. Frozen storage would be suitable for most chemical analyses, while microbiological analyses would require only cooling or ambient temperature. Some compounds, e.g. vitamins may be sensitive to optical radiation (ultraviolet and visible) and should be protected from such radiation, while e.g. samples high in fat prone to oxidation might also benefit from being stored in an inert atmosphere. Proper homogenisation of samples prior to analysis is key to reduce measurement uncertainty. Storage time before analysis should be kept as short as possible so that the sample remains as representative to the original product as possible.

Data generated from analytical methods must be reliable, consistent and have a high scientific standard. The choice of analytical method is therefore central and should adhere to the principles stated in article 34 of EU 2017/625; if more than one method is available, standardised methods from CEN (The European Committee for Standardization) or developed by European Reference Laboratories should be preferred prior to other validated methods. Laboratories chosen to carry out the analyses should be accredited for the use of

these methods. For the cost-effective utilisation of samples, multi-methods where several chemical compounds can be measured simultaneously in a food commodity should be used. Moreover, multiple analytical outcomes, including nutrient analyses, of the same samples enable the assessment of mixture effects of chemicals and facilitates risk-benefit assessment of foods.

5.3 Review and reporting phase

The world is becoming increasingly data-driven and data resulting from food sampling should be organised in a computerised information management system. A fractionated collection and subsequent evaluation of surveillance data through each individual surveillance program is less efficient than a database containing all available data from Norwegian surveillance and monitoring. A national database with harmonised data description from all the different surveillance and monitoring programs would facilitate the collection of and subsequent assessment of data in the area of food safety. Such a framework is already in use; the Standard Sample Description (SSD2) developed by EFSA is a format for describing food samples and analytical results from surveillance programs in the EU and includes descriptions of food samples such as country of origin, product, time of sampling, analytical method, limit of detection, etc. (EFSA, 2013). SSD2 is complemented by FoodEx2 (EFSA, 2015), a standard for classifying and describing food. Used together with food consumption data, these systems provide the necessary input for exposure assessments which may enable an understanding of factors that may influence the risk from a certain "undesirable chemical substance/food item" pair such as seasonality, geographic conditions and processing of foods, and subsequently lead to a more comprehensive knowledge platform for design of risk-based surveillance. An efficient way of collecting and compiling comparable data, would be to format national data in a standardised system such as SSD2 and to create a data repository that could be used for national assessments. Given the multi-national nature of the food chain, these data should also easily be made accessible for other risk assessment bodies such as EFSA, ensuring that data flows in a harmonised and consistent manner between the different systems. The data generated from surveillance programs should be analysed with appropriate statistical methods and interpreted in a wider context, e.g. by forming a working group with a broad range of experts to prioritise the substances and frequently (e.g. yearly) re-evaluate the list of prioritised substances using the most recent monitoring information.

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Appendix A: Substances included in the VKM (2019) ranking report

An overview of the substances and the scoring of the substances in the ranking report (VKM, 2019) is given in table A-1. The ranking of the substances was based on their inherent toxicity (hazard) and level of exposure (based on both occurrence and intake). In addition, vulnerable groups, adequacy of toxicity data and of exposure data (occurrence and intake) were considered. The scores were as follows:

- Toxicity and exposure: minimum score = 2, maximum score = 6
- Vulnerable groups: minimum score = 0, maximum score = 1
- Lack of toxicity data: minimum score = 0, maximum score = 1
- Lack of exposure data: minimum score = 0, maximum score = 1

Table A-1. Chemical substances included in the ranking report (VKM et al., 2019). * The substance is not included in the knowledge base. ** Substances scored 4 or higher are included in the knowledge base.

Substance group	Subgroup	Substance	Score for risk (toxicity and exposure) **	Score for vulnerable groups	Score for lack of toxicity data	Score for lack of exposure data	Total score
Natural toxins	Mycotoxins	Aflatoxins (AFLAs)	6.0	0.5	0.5	0.5	7.5
		Alternariol (AOH) and Alternariol methyl ether (AME)	4.0	0.5	1.0	0.5	6.0
		Deoxynivalenol (DON) and modified forms	4.0	1.0	0.5	0.5	6.0
		Enniatins (ENNs)	4.0	0.5	1.0	1.0	6.5
		Ochratoxin A (OTA)	4.0	0.0	0.5	1.0	5.5
		Patulin (PAT)	2.0	0.0	0.5	1.0	3.5
		T-2 (T2) and HT-2 (HT2) toxins and modified forms	6.0	1.0	0.5	1.0	8.5
		Zearalenone (ZEN) and modified forms	2.0	0.0	1.0	0.5	3.5
	Plant toxins	Solanine and Chaconine	4.0	1.0	0.5	1.0	6.5
		Cyanogenic glucosides	4.0	0.5	1.0	0.0	5.5
		Erucic acid	4.0	0.5	0.5	0.0	5.0
		Glucosinolates*	2.0	0.5	1.0	0.5	4.0
		Pyrrolizidine alkaloids (PAs)	6.0	1.0	0.5	0.5	8.0
		Tropane alkaloids (TAs)	4.0	0.5	1.0	0.5	6.0
	Marine algae toxins	Azaspiracids (AZAs)	4.0	1.0	0.5	1.0	6.5
		Tetrodotoxin (TTX) and analoges	4.0	1.0	0.5	1.0	6.5
	Freshwater algae toxins	Microcystins	4.0	0.5	1.0	1.0	6.5
		Aluminium	4.0	0.5	0.0	0.0	4.5

Metals and metalloids		Arsenic – inorganic	6.0	0.5	0.0	0.0	6.5
		Arsenic – organic*	2.0	0.0	1.0	1.0	4.0
		Cadmium	6.0	0.5	0.0	0.0	6.5
		Chromium *	2.0	0.0	0.0	1.0	3.0
		Lead	6.0	1.0	0.0	0.5	7.5
		Methylmercury	6.0	1.0	0.0	0.0	7.0
		Nickel *	2.0	1.0	0.0	0.0	3.0
Persistent organic pollutants (POPs)	Brominated flame retardants	Polybrominated diphenyl ethers (including decabromodiphenyl ether)*	2.0	0.5	0.5	0.5	3.5
		Hexabromocyclododecane*	2.0	0.0	0.5	0.5	3.0
		Hexabromobenzene*	2.0	0.0	1.0	1.0	4.0
		Decabromo-diphenyl ethane (DBDPE)*	2.0	0.0	1.0	1.0	4.0
		1,2-Bis(2,4,6-tribromophenoxy)ethane*	2.0	0.0	1.0	1.0	4.0
		2,4,6-Tribromophenol*	2.0	0.0	1.0	1.0	4.0
	Dechloranes	Dechlorane plus*	3.0	0.0	1.0	1.0	5.0
	Dioxins and Dioxin-like polychlorinated biphenyls (DL-PCBs)	Dioxins and DL-PCBs	6.0	1.0	0.5	0.5	8.0
	Non-dioxin-like polychlorinated biphenyls (NDL-PCBs)	NDL-PCBs	4.0	1.0	0.5	0.0	5.5
	Perfluorinated and polyfluorinated alkyl substances (PFAS)	Perfluorooctane sulfonate, Perfluorooctanoic acid	6.0	0.5	0.5	1.0	8.0
		Perfluorohexane sulfonic acid, Perfluorononanoic acid, Perfluorodecanoic acid,	4.0	0.5	1.0	1.0	6.5

		Perfluoroundecanoic acid, and Perfluoroheptane sulfonate					
	Siloxanes	Octamethylcyclotetra-siloxane*	2.0	0.5	0.5	0.5	3.5
		Decamethylcyclopenta-siloxane*	2.0	0.5	0.5	0.5	3.5
		Dodecamethylcyclohexa-siloxane*	2.0	0.5	1.0	0.5	4.0
Substances in food contact materials	Bisphenols	Bisphenol A*	2.0	0.0	0.5	0.5	3.0
		Bisphenol S, bispenol F and bisphenol AF	4.0	0.5	1.0	1.0	6.5
	Phthalates	Bis(2-ethylhexyl) phthalate*	2.0	0.5	0.5	0.5	3.5
		Butyl-benzyl-phthalate*	2.0	0.5	0.5	0.5	3.5
		Di-butylphthalate*	2.0	0.5	0.5	0.5	3.5
		Di-isodecyl phthalate*	2.0	0.5	0.5	0.5	3.5
		Di-isononyl phthalate*	2.0	0.5	0.5	0.5	3.5
Flavourings		Caffeine	4.0	0.5	1.0	1.0	6.5
Additives	Nitrites and nitrates	Sodium and potassium salts of nitrite and nitrate	4.0	0.5	0.5	0.5	5.5
	Phosphates	Phosphoric acid-phosphates	6.0	1.0	0.5	0.0	7.5
	Sweeteners	Acesulfame K*	3.0	0.0	0.5	1.0	4.5
		Sucralose*	2.0	0.0	0.0	1.0	3.0
	Synthetic antioxidants	Butylated hydroxyanisole*	2.0	0.5	0.5	1.0	4.0
		Butylated hydroxytoluene	4.0	0.0	0.0	1.0	5.0
		Ethoxyquin	4.0	0.5	1.0	1.0	6.5
Process-induced contaminants	Acrylamide	Acrylamide	6.0	1.0	0.5	0.5	8.0
	Esterified 3- and 2-monochloropropane-1,2-	3-Monochloropropane-1,2-diol and its fatty acid esters	4.0	0.5	0.5	0.5	5.5
		Glycidyl fatty acid esters	6.0	0.5	1.0	0.5	8.0

	diol (MCPD) and glycidyl esters (GEs)						
	Furans	Furan, 2-methylfuran and 3-methylfuran	6.0	0.5	1.0	1.0	8.5
	Heterocyclic aromatic amines (HAAs)	2-Amino-1-methyl-6-phenylimidazo[4,5-*b*]pyridine	5.0	0.5	1.0	0.5	7.0
		HAAs in general	5.0	0.5	1.0	0.5	7.0
	Polycyclic aromatic hydrocarbons (PAHs)	Polycyclic aromatic hydrocarbons in general were included in the VKM ranking report (2019)	4.0	1.0	0.5	0.5	6.0
«Other substances»		L-Aspartic acid*	3.0	0.5	0.5	0.5	4.5
		L-Carnitine and L-carnitine-L-tartrate*	2.0	1.0	0.5	0.5	4.0
		Coenzyme Q10*	2.0	0.0	0.5	0.5	3.0
		Conjugated linoleic acids*	2.0	1.0	0.5	0.5	4.0
		Creatine*	2.0	0.5	0.5	0.5	3.5
		Curcumin*	4.0	1.0	0.5	0.5	6.0
		L-Cysteine and L-Cystine*	2.0	0.5	0.5	0.5	3.5
		Docosahexaenoic acid*	4.0	0.0	1.0	0.5	5.5
		Docosapentaenoic acid*	2.0	0.0	0.5	0.5	3.0
		D-Glucurono-γ-lactone*	2.0	0.0	0.5	0.5	3.0
		Eicosapentaenoic acid*	2.0	0.0	0.5	0.5	3.0
		Inositol*	2.0	0.5	0.5	0.5	3.5
		Lycopene*	4.0	1.0	0.5	0.5	6.0
		L-Methionine*	2.0	0.5	1.0	0.5	4.0
		Piperine*	3.0	0.5	0.5	0.5	4.5
		Taurine*	2.0	0.0	0.5	0.5	3.0

		L-Tyrosine*	3.0	0.0	1.0	0.5	4.5
Trace element		Iodine	5.0	1.0	0.5	0.5	

Appendix B: Regulated contaminants

An overview of substances regulated in the COMMISSION REGULATION (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs is given in the tables below.

Nitrate

Substance name	Food
Nitrate	Fresh spinach (*Spinacia oleracea*)
	Preserved, deep-frozen or frozen spinach
	Fresh Lettuce (*Lactuca sativa L.*)
	'Iceberg' type lettuce
	Rucola (*Eruca sativa, Diplotaxis sp., Brassica tenuifolia, Sisymbrium tenuifolium*)
	Processed cereal-based foods and baby foods for infants and young children

Mycotoxins

Substance name	Food
Aflatoxins	Groundnuts (peanuts) and other oilseeds
	Almonds, pistachios and apricot kernels
	Hazelnuts and Brazil nuts
	Tree nuts
	Dried fruit
	All cereals and all products derived from cereals
	Maize and rice
	Raw milk, heat-treated milk and milk for the manufacture of milk-based products
	Following species of spices: *Capsicum* spp. (dried fruits thereof, whole or ground, including chillies, chilli powder, cayenne and paprika) *Piper* spp. (fruits thereof, including white and black pepper), *Myristica fragrans* (nutmeg), *Zingiber officinale* (ginger), *Curcuma longa* (turmeric), and mixtures of spices containing one or more of the abovementioned spices
	Infant formulae and follow-on formulae, including infant milk and follow-on milk
	Dried figs
Ochratoxin A	Unprocessed cereals and products derived from unprocessed cereals
	Dried vine fruit (currants, raisins and sultanas)
	Roasted coffee beans and ground roasted coffee
	Soluble coffee
	Grape juice

Substance name	Food
	Spices, including dried spices *Piper spp*. (fruits thereof, including white and black pepper), *Myristica fragrans* (nutmeg), *Zingiber officinale* (ginger), *Curcuma longa* (turmeric), *Capsicum* spp. (dried fruits thereof, whole or ground, including chillies, chilli powder, cayenne and paprika), mixtures of spices containing one of the abovementioned spices
	Liquorice (*Glycyrrhiza glabra, Glycyrrhiza inflate* and other species)
Patulin	Fruit juices
	Solid apple products
	Baby foods other than processed cereal-based foods for infants and young children
Deoxynivalenol	Unprocessed cereals
	Unprocessed maize
	Cereals intended for direct human consumption
	Pasta (dry)
	Bread (including small bakery wares), pastries, biscuits, cereal snacks and breakfast cereals
	Processed cereal-based foods and baby foods for infants and young children
Zearalenone	Unprocessed cereals
	Unprocessed maize
	Cereals intended for direct human consumption
	Refined maize oil
	Bread (including small bakery wares), pastries, biscuits, cereal snacks and breakfast cereals, excluding maize-snacks and maize-based breakfast cereals
	Maize intended for direct human consumption
	Processed cereal-based foods
Fumonisins	Unprocessed maize
	Maize intended for direct human consumption
	Processed maize-based foods and baby foods for infants and young children
T-2 and HT-2 toxin	Unprocessed cereals
Citrinin	Food supplements based on rice fermented with red yeast *Monascus purpureus*
Ergot sclerotia and ergot alkaloids	Unprocessed cereals (not corn and rice)
	Cereal milling products excluding corn and rice
	Bread (including small bakery wares), pastries, biscuits, cereal snacks, breakfast cereals and pasta
	Cereal-based food for infants and young children

Metals

Substance name	Food
Lead	Raw milk, heat-treated milk and milk for the manufacture of milk-based products

Substance name	Food
	Infant formulae, follow-on formulae and young child formulae
	Processed cereal-based foods and baby foods for infants and young children
	Meat an offal of bovine animals, sheep, pig and poultry
	Muscle meat of fish
	Cephalopods
	Crustaceans
	Bivalve molluscs
	Cereals and pulses
	Root and tuber vegetables (excluding salsifies, fresh ginger and fresh turmeric), bulb vegetables, flowering brassica, head brassica, kohlrabies, legume vegetables and stem vegetables
	Leafy brassica, salsify, the following fungi *Agaricus bisporus* (common mushroom), *Pleurotus ostreatus* (Oyster mushroom), *Lentinula edodes* (Shiitake mushroom) and leafy vegetables (excluding fresh herbs)
	Wild fungi, fresh turmeric and fresh ginger
	Fruiting vegetables and sweetcorn
	Fruit
	Fats and oils, including milk fat
	Fruit juices
	Food supplements
	Honey
	Dried spices
	Salt
Cadmium	Fruits and tree nuts
	Root and tuber vegetables
	Bulb vegetables
	Fruiting vegetables
	Brassica vegetables
	Leaf vegetables and herbs
	Legume vegetables
	Stem vegetables
	Fungi
	Pulses and proteins from pulses
	Oilseeds
	Cereals
	Specific cocoa and chocolate products
	Meat (excluding offal) of bovine animals, sheep, pig and poultry
	Horsemeat, excluding offal
	Liver of bovine animals, sheep, pig, poultry and horse
	Kidney of bovine animals, sheep, pig, poultry and horse
	Muscle meat of fish
	Crustaceans muscle meat
	Bivalve molluscs
	Cephalopods

Substance name	Food
	Infant formulae, follow-on formulae and foods for special medical purposes intended for infants and young children and young child formulae
	Processed cereal-based foods and baby foods for infants and young children
	Food supplements
	Salt
Mercury	Fishery products and muscle meat of fish
	Food supplements
Tin (inorganic)	Canned foods other than beverages
	Canned beverages, including fruit juices and vegetable juices
	Canned baby foods and processed cereal-based foods for infants and young children, excluding dried and powdered products
	Canned infant formulae and follow-on formulae (including infant milk and follow-on milk), excluding dried and powdered products
Arsenic (inorganic)	Non-parboiled milled rice (polished or white rice)
	Parboiled rice and husked rice
	Rice waffles, rice wafers, rice crackers and rice cakes
	Rice destined for the production of food for infants and young children

3-Monochloropropanediol (3-MCPD), 3-MCPD fatty acid esters and glycidyl fatty acid esters

Substance name	Food
3-monochloropropanediol	Hydrolysed vegetable protein
	Soy sauce
Glycidyl fatty acid esters, expressed as glycidol	Vegetable oils and fats, fish oils and oils from other marine organisms
	Infant formula, follow-on formula and foods for special medical purposes intended for infants and young children and young-child formula
Sum of 3-monochloropropanediol (3-MCPD) and 3-MCPD fatty acid esters, expressed as 3-MCPD	Vegetable oils and fats, fish oils and oils from other marine organisms
	Infant formula, follow-on formula and foods for special medical purposes intended for infants and young children and young-child formula

Dioxins and PCBs

Substance name	Food
Dioxins and PCBs	Meat and meat products of bovine animals and sheep, poultry, pigs
	Liver of terrestrial animals
	Muscle meat of fish and fishery products and products thereof
	Fish liver and derived products thereof
	Raw milk and dairy products

Substance name	Food
(Sum of PCB28, PCB52, PCB101, PCB138, PCB153 and PCB180)	Hen eggs and egg products
	Fat of bovine animals and sheep, poultry, pigs
	Vegetable oils and fats
(Sum of dioxins and dioxin-like PCBs)	Foods for infants and young children

Polycyclic aromatic hydrocarbons

Substance name	Food
Benzo(a)pyrene, benz(a)anthracene, benzo(b)fluoranthene and chrysene	Oils and fats
	Smoked meat and smoked meat products
	Muscle meat of smoked fish and smoked fishery products
	Bivalve molluscs (smoked)
	Processed cereal-based foods and baby foods for infants and young children
	Infant formulae and follow-on formulae, including infant milk and follow-on milk
	Cocoa fibre and products derived from cocoa fibre,
	Banana chips
	Food supplements containing propolis, royal jelly, spirulina or their preparations
	Dried herbs
	Dried spices

Melamine and its structural analogues

Substance name	Food
Melamine	Food with the exception of infant formulae and follow-on formulae
	Powdered infant formulae and follow-on formulae

Inherent plant toxins

Substance name	Food
Erucic acid, including erucic acid bound in fat	Vegetable oils and fats
	Camelina oil, mustard oil and borage oil
	Mustard
	Seafood; in particular fatty fish, liver and fish oil
Tropane alkaloids (atropine and scopolamine)	Processed cereal-based foods and baby foods for infants and young children, containing millet, sorghum, buckwheat or their derived products

Substance name	Food
Hydrocyanic acid, including hydrocyanic acid bound in cyanogenic glycosides	Unprocessed whole, ground, milled, cracked, chopped apricot kernels

Perchlorate

Substance name	Food
Perchlorate	Fruits and vegetables
	Tea (*Camellia sinensis*), dried Herbal and fruit infusions, dried
	Infant formula, follow-on formula, foods for special medical purposes intended for infants and young children and young child formula, babyfood, processed cereal based food

Appendix C: Subgroups of foods within each of the main food categories

Food subgroups for all age groups

Food subgroups are presented for all main food categories displayed above the **red** line in Tables C-1 to C-7, which contribute to at least 90% of the total intake, when ranked in descending order. A minimum of two food subgroups are presented for all main food categories, even when a single food subcategory alone contributes to > 90% of the total intake within the main food category. The intake of the selected food subgroups is presented in separate tables for the same age groups as for the main food categories:

- Children 1 year
- Children 2 years
- Children 4 years
- Children 8- 9 years
- Adolescents 12-13 years
- Women 18-45 years (fertile age)
- Adults 18-70 years

Table C-1. Top subgroups of foods consumed by 1-year-olds (from Spedkost3), for each of the main food categories displayed above the red line in Table 3.3-1 (n = 1957). Rows in colours show the main food categories as presented in Table 4.3-1, under which the subcategories belong. The food subgroups are displayed in descending order by mean intake in grams/day on group level, and the numbers are rounded.

Main food categories	*Main food categories in Norwegian*	g/ day	Total intake (%)	Cumulative total intake (%)*	Consumers (%)
Infant foods	***Spebarnmat***	**724**			**100**
Porridge for infants	*Spebarnsgrøt*	293	40	40	97
Formula milk for infants	*Melkerstatning for spebarn*	165	23	63	47
Fruit purees for infants	*Fruktpuré/fruktdessert spebarn*	155	21	85	95
Ready-made dinners for infants	*Middagsglass spebarn*	107	15	100	59
Beverages	***Drikkevarer***	**284**			**100**
Water, mineral water	*Vann, mineralvann*	276	97	97	100
Cordial, soda with sugar	*Saft og brus med sukker*	5	2	99	16
Cordial, soda without sugar	*Saft og brus uten sukker*	2	0,8	100	7
Milk and dairy products**	***Melk og meieriprodukter****	**96**			**92**
Milk and yoghurt	*Melk og yoghurt*	*95*	99	99	92
Cream, sour cream, ice cream	*Fløte, rømme, iskrem*	*0,6*	1	99	20
Fruit and berries	***Frukt og bær***	**77**			**98**
Fresh fruit	*Fersk frukt*	68	89	89	97
Fruit juice and smoothie	*Fruktjuice og smoothie*	6	7	96	*20*
Jam and canned fruit	*Syltetøy og hermetisk frukt*	3	4	100	*40*
Bread	***Brød***	**66**			**98**
Bread, >50% wholegrain flour	Brød, >50% sammalt mel	*50*	76	76	86
Bread, <50% wholegrain flour	Brød, <50% sammalt mel	*13*	19	96	34
Bread, white flour	Brød, siktet mel	*2*	2	98	46
Vegetables	***Grønnsaker***	**64**			**98**
Fresh and frozen vegetables	*Friske og fryste grønnsaker*	59	*92*	92	*98*
Vegetable based dishes	*Grønnsaksretter*	2	*3*	95	*24*
Canned vegetables	*Hermetiske grønnsaker*	2	*2*	97	*87*

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products not including butter and cheese.

Table C-2. Top subgroups of foods consumed by 2-year-olds (from Småbarnskost3), for each of the main food categories displayed above the red line in Table 3.3-2 (n =1413). Rows in colors show the main food categories as presented in Table 4.3-2, under which the subcategories belong. The food subgroups are displayed in descending order by mean intake in grams/day on group level, and the numbers are rounded.

Main food categories	*Main food categories in Norwegian*	g/ day	Total intake (%)	Cumulative total intake (%)*	Consumers (%)
Beverages	***Drikkevarer***	**563**			**100**
Water, mineral water	*Vann, mineralvann*	480	85	85	100
Cordial, soda with sugar	*Saft og brus med sukker*	42	8	93	64
Cordial, soda without sugar	*Saft og brus uten sukker*	32	6	98	31
Milk and dairy products**	***Melk og meieriprodukter****	**424**			**99**
Milk and yoghurt	*Melk og yoghurt*	416	98	98	99
Cream, sour cream, ice cream	*Fløte, rømme, iskrem*	8	2	100	78
Infant foods	***Spebarnmat***	**205**			**97**
Porridge for infants	*Spebarnsgrøt*	126	61	61	91
Fruit purees for infants	*Fruktpuré/fruktdessert spebarn*	58	28	89	74
Formula milk for infants	*Melkerstatning for spebarn*	13	6	96	6
Fruits and berries	***Frukt og bær***	**162**			**100**
Fresh fruit	*Fersk frukt*	125	77	77	100
Fruit juice and smoothie	*Fruktjuice og smoothie*	29	18	95	53
Jam and canned fruit	*Syltetøy og hermetisk frukt*	8	5	100	75
Bread	***Brød***	**113**			**100**
Bread, >50% wholegrain flour	*Brød, >50% sammalt mel*	*83*	73	73	90
Bread, <50% wholegrain flour	*Brød, <50% sammalt mel*	*20*	18	91	37
Crispbread	*Knekkebrød*	*5*	5	96	51

Vegetables	***Grønnsaker***	**86**			**100**
Fresh and frozen vegetables	*Friske og fryste grønnsaker*	71	83	83	99
Canned vegetables	*Hermetiske grønnsaker*	7	8	90	99
Vegetable soups	*Grønnsakssupper*	6	7	97	70

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products not including butter and cheese.

Table C-3. Top subgroups of foods consumed by 4-year-olds (from Ungkost3), for each of the main food categories displayed above the red line in Table 3.3-3 (n = 399). Rows in colors show the main food categories as presented in Table 4.3-3, under which the subcategories belong. The food subgroups are displayed in descending order by mean intake in grams/day on group level, and the numbers are rounded.

Main food categories	*Main food categories in Norwegian*	g/ day	Total intake (%)	Cumulative total intake (%)*	Consumers (%)
Beverages	**Drikkevarer**	**439**			**100**
Water, mineral water	*Vann, mineralvann*	344	78	78	99
Cordial, soda with sugar	*Saft og brus med sukker*	55	13	91	64
Cordial, soda without sugar	*Saft og brus uten sukker*	30	7	98	31
Milk and dairy products**	**Melk og meieriprodukter****	**313**			**99**
Milk and yoghurt	*Melk og yoghurt*	299	96	96	98
Cream, sour cream, ice cream	*Fløte, rømme, iskrem*	14	4	100	64
Fruit, berries	**Frukt og bær**	**191**			**100**
Fresh fruit	*Fersk frukt*	109	57	57	97
Fruit juice and smoothie	*Fruktjuice og smoothie*	71	37	94	72
Jam and canned fruit	*Syltetøy og hermetisk frukt*	10	5	99	64
Bread	**Brød**	**118**			**100**
Bread, <50% wholegrain flour	*Brød, <50% sammalt mel*	49	42	42	82
Bread, >50% wholegrain flour	*Brød, >50% sammalt mel*	41	34	76	73

Bread, white flour	*Brød, siktet mel*	19	16	93	66
Crispbread	*Knekkebrød*	7	6	98	67
Other grain products* **	**Andre kornprodukter*** **	**93**			**98**
Porridge	Grøt	41	43	43	50
Flour, rice, pasta	Mel, ris, pasta	35	38	81	89
Breakfast cereals	Frokostblandinger	13	14	95	64
Vegetables	**Grønnsaker**	**67**			**99**
Fresh and frozen vegetables	Friske og fryste grønnsaker	52	78	78	96
Canned vegetables	Hermetiske grønnsaker	10	14	92	79
Vegetable soups	*Grønnsaksupper*	4	7	99	8
Meat and offal	**Kjøtt og innmat**	**60**			**99**
Red meat	*Rødt kjøtt*	51	85	85	99
White meat	*Hvitt kjøtt*	9	15	100	48

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products not including butter and cheese.
*** Cereals, rice, corn products, biscuits, not including cakes and cookies.

Table C-4. Top subgroups of foods consumed by 8-9-year-olds (from Ungkost3), for each of the main food categories displayed above the red line in Table 3.3-4 (n = 636). Rows in colours show the main food categories as presented in Table 4.3-4, under which the subcategories belong. The food subgroups are displayed in descending order by mean intake in grams/day on group level, and the numbers are rounded.

Main food categories	*Main food categories in Norwegian*	g/ day	Total intake (%)	Cumulative total intake (%)*	Consumers (%)
Beverages	***Drikkevarer***	**575**	**34**		**100**
Water, mineral water	*Vann, mineralvann*	371	64	64	98

Cordial, soda with sugar	*Saft og brus med sukker*	141	24	89	79
Cordial, soda without sugar	*Saft og brus uten sukker*	51	9	98	39
Milk and dairy products**	***Melk og meieriprodukter****	**330**	**20**	**54**	**99**
Milk and yoghurt	*Melk og yoghurt*	313	95	95	99
Cream, sour cream, ice cream	*Fløte, rømme, iskrem*	17	5	100	97
Fruit and berries	***Frukt og bær***	**159**	**9**	**63**	**95**
Fruit juice and smoothie	*Fruktjuice og smoothie*	81	51	51	61
Fresh fruit and berries	*Fersk frukt og bær*	67	42	93	81
Jam and canned fruit	*Syltetøy og hermetisk frukt*	11	7	100	52
Bread	***Brød***	**156**	**9**	**73**	**100**
Bread, >50% wholegrain flour	*Brød, >50% sammalt mel*	51	33	33	69
Bread, <50% wholegrain flour	*Brød, <50% sammalt mel*	51	32	65	72
Bread, white flour	*Brød, siktet mel*	46	30	95	80
Other grain products***	***Andre kornprodukter*****	**98**	**6**	**79**	**96**
Flour, rice, pasta	*Mel, ris, pasta*	45	46	46	84
Porridge	*Grøt*	30	30	76	26
Breakfast cereals	*Frokostblandinger*	17	17	93	54
Meat and offal	***Kjøtt og innmat***	**96**	**6**	**84**	**100**
Red meat	*Rødt kjøtt*	83,7	87	87	99
White meat	*Hvitt kjøtt*	12	13	100	41
Vegetables	***Grønnsaker***	**81**	**5**	**89**	**97**
Fresh and frozen vegetables	*Friske og fryste grønnsaker*	58	71	71	93
Canned vegetables	*Hermetiske grønnsaker*	18	22	93	78
Vegetable soups	*Grønnsaksupper*	5	6	99	5
Sweet baked goods	***Søte bakverk***	**37**	**2**	**91**	**73**
Cakes	*Kaker*	19	52	52	43
Sweet rolls, Danish and waffles	*Gjærbakst og vafler*	15	40	92	38
Cookies and biscuits	*Kjeks og småkaker*	3	8	100	27

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products not including butter and cheese.
*** Cereals, rice, corn products, biscuits, not including cakes and cookies.

Table C-5. Top subgroups of foods consumed by 12-13-year-olds (from Ungkost3), for each of the main food categories displayed above the red line in Table 3.3-5 (n = 687). Rows in colors show the main food categories as presented in Table 4.3-5, under which the subcategories belong. The food subgroups are displayed in descending order by mean intake in grams/day on group level, and the numbers are rounded.

Main food categories	*Main food categories in Norwegian*	g/ day	Total intake (%)	Cumulative total intake (%)*	Consumers (%)
Beverages	***Drikkevarer***	**712**	**39**		**100**
Water, mineral water	*Vann, mineralvann*	421	59	59	95
Cordial, soda with sugar	*Saft og brus med sukker*	190	27	86	77
Cordial, soda without sugar	*Saft og brus uten sukker*	72	10	96	38
Tea	*Te*	24	3	99	21
Milk and dairy products**	***Melk og meieri-produkter****	**304**	**17**	**56**	**95**
Milk and yoghurt	*Melk og yoghurt*	287	94	94	92
Cream, sour cream, ice cream	*Fløte, rømme, iskrem*	18	6	100	62
Bread	***Brød***	**169**	**9**	**65**	**100**
Bread, white flour	*Brød, siktet mel*	64	38	38	82
Bread, <50% wholegrain flour	*Brød, <50% sammalt mel*	52	31	69	72
Bread, >50% wholegrain flour	*Brød, >50% sammalt mel*	43	25	94	60
Fruit and berries	***Frukt og bær***	**149**	**8**	**73**	**89**
Fruit juice and smoothie	*Fruktjuice og smoothie*	91	61	61	60
Fresh fruit and berries	*Fersk frukt og bær*	48	32	93	59
Jam and canned fruit	*Syltetøy og hermetisk frukt*	9	6	99	41
Meat and offal	***Kjøtt og innmat***	**113**	**6**	**79**	**99**

Read meat	*Rødt kjøtt*	97	85	85	98
White meat	*Hvitt kjøtt*	16	14	99	47
Other grain products* **	***Andre korn-produkter****	**91**	**5**	**84**	**94**
Flour, rice, pasta	*Mel, ris, pasta*	47	51	51	78
Porridge	*Grøt*	24	27	78	19
Breakfast cereals	*Frokost-blandinger*	14	15	93	41
Vegetables	***Grønnsaker***	**87**	**5**	**89**	**96**
Fresh and frozen vegetables	*Friske og fryste grønnsaker*	58	67	67	91
Canned vegetables	*Hermetiske grønnsaker*	25	28	95	81
Vegetable based dishes	*Grønnsaksretter*	1	1	96	5
Potato and potato products	***Poteter og potetprodukter***	**39**	**2**	**91**	**69**
Bolied potatoes	*Kokte poteter*	19	49	49	45
Mashed potatoes	*Potetmos*	9	22	71	14
Potato fries	*Pommes frites*	4	9	80	13
Fried potatoes	*Stekte poteter*	3	9	89	9
Gratinated potatoes	*Gratinerte poteter*	2	4	93	3

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products not including butter and cheese.
*** Cereals, rice, corn products, biscuits, not including cakes and cookies.

Table C-6. Top subgroups of foods consumed by women 18-45 years (from Norkost3), for each of the main food categories displayed above the red line in Table 3.3-6 (n = 435). Rows in colors show the main food categories as presented in Table 4.3-6, under which the subcategories belong. The food subgroups are displayed in descending order by mean intake in grams/day on group level.

Main food categories	*Main food categories in Norwegian*	g/ day	Total intake (%)	Cumulative total intake (%)*	Consumers (%)
Beverages	***Drikkevarer***	**2112**			**100**

Water, mineral water	*Vann, mineralvann*	1235	58	58	97
Coffee	*Kaffe*	325	15	73	69
Tea	*Te*	212	10	83	52
Cordial, soda without sugar	*Saft og brus uten sukker*	148	7	90	32
Fruit and berries	***Frukt og bær***	**287**			**95**
Fresh fruit and berries	*Fersk frukt og bær*	143	50	50	84
Fruit juice and smoothie	*Fruktjuice og smoothie*	123	43	93	57
Jam and canned fruit	*Syltetøy og hermetisk frukt*	14	5	98	50
Milk and dairy products**	**Melk og meieriprodukter****	**286**			**94**
Milk and yoghurt	*Melk og yoghurt*	268	94	94	89
Cream, sour cream, ice cream	*Fløte, rømme, iskrem*	18	6	100	46
Vegetables	***Grønnsaker***	**142**			**98**
Fresh and frozen vegetables	Friske og fryste grønnsaker	123	87	87	96
Canned vegetables	Hermetiske grønnsaker	18	13	99	64
Dried legumes	*Tørkede belgfrukter*	1	0,7	100	10
Bread	***Brød***	**140**			**99**
Bread, >50% wholegrain flour	*Brød, >50% sammalt mel*	63	45	45	65
Bread, <50% wholegrain flour	*Brød, <50% sammalt mel*	39	28	73	55
Bread, white flour	*Brød, 100% siktet mel*	20	14	87	41
Other breadproducts	*Brødvarer, andre*	18	13	100	61
Meat and offal	***Kjøtt og innmat***	**108**			**97**
Red meat	*Rødt kjøtt*	80	74	74	92
White meat	*Hvitt kjøtt*	28	26	100	44
Other grain products***	***Andre kornprodukter******	**70**			**89**
Pizza and pies	*Pizza og pai*	29	41	41	22
Flour, rice, pasta	*Mel, ris, pasta*	23	33	74	73
Breakfast cereals	*Frokostblandinger*	16	22	96	33

Potato and potato products	***Poteter og potetprodukter***	**44**			**55**
Boiled or baked potatoes	*Kokte eller bakte poteter*	41	93	93	49
Potato fries	*Pommes frites*	3	7	100	5
Fish and seafood	***Fisk og sjømat***	**44**			**54**
Fatty fish	*Fet fisk*	10	24	24	16
Fish products	*Fiskeprodukter*	8	18	42	12
Fish spread	*Fiskepålegg*	7	16	58	23
Lean and semi fat fish	*Mager og halvfet fisk*	6	14	72	7
Fish dishes	*Fiskeretter*	5	12	84	3
Other unspesified fish	*Annen uspesifisert fisk*	5	12	96	6

* The accumulated total intake (in percent) is shown.

** Milk, cream, yoghurt, and other dairy products not including butter and cheese.

*** Cereals, rice, corn products, biscuits, not including cakes and cookies.

Table C-7. Top subgroups of foods consumed by adults 18-70 years (from Norkost3), for each of the main food categories displayed above the red line in Table 3.3-7 (n = 1787). Rows in colors show the main food categories as presented in Table 4.3-7, under which the subcategories belong. The food subgroups are displayed in descending order by mean intake in grams/day on group level.

Main food categories	*Main food categories in Norwegian*	g/ day	Total intake (%)	Cumulative total intake (%)*	Consumers (%)
Beverages	***Drikkevarer***	**2137**			**100**
Water, mineral water	*Vann, mineralvann*	1065	50	50	96
Coffee	*Kaffe*	519	24	74	81
Tea	*Te*	176	8	82	41
Cordial, soda with sugar	*Saft og brus med sukker*	124	6	88	33
Cordial, soda without sugar	*Saft og brus uten sukker*	112	5	93	24

Milk and dairy products**	**Melk og meieriprodukter****	**334**			**94**
Milk and yoghurt	*Melk og yoghurt*	312	94	94	88
Cream, sour cream, ice cream	*Fløte, rømme, iskrem*	22	6	100	48
Fruit and berries	***Frukt og bær***	**285**			**94**
Fresh fruit and berries	*Fersk frukt og bær*	154	54	54	82
Fruit juice and smoothie	*Fruktjuice og smoothie*	107	37	91	48
Jam and canned fruit	*Syltetøy og hermetisk frukt*	18	6	97	53
Bread	***Brød***	**171**			**99**
Bread, >50% wholegrain flour	*Brød, >50% sammalt mel*	83,6	49	49	99
Bread, <50% wholegrain flour	*Brød, <50% sammalt mel*	51,4	30	79	69
Bread, white flour	*Brød, 100% siktet mel*	21,9	13	92	58
Vegetables	***Grønnsaker***	**147**			**97**
Fresh and frozen vegetables	*Friske og fryste grønnsaker*	124	84	84	95
Canned vegetables	*Hermetiske grønnsaker*	21	14	99	60
Dried legumes	*Tørkede belgfrukter*	2	1	100	11
Meat and offal	***Kjøtt og innmat***	**131**			**97**
Red meat	*Rødt kjøtt*	103	79	79	94
White meat	*Hvitt kjøtt*	27	5	84	37
Other grain products***	***Andre kornprodukter*****	**68**			**84**
Pizza and pies	*Pizza og pai*	29	43	43	18
Flour, rice, pasta	*Mel, ris, pasta*	21	31	74	70
Breakfast cereals	*Frokostblandinger*	16	23	97	28
Fish and seafood	***Fisk og sjømat***	**67**			**65**
Lean and semi fat fish	*Mager og halvfet fisk*	16	23	23	13
Fatty fish	*Fet fisk*	15	22	45	20
Fish products	*Fiskeprodukter*	13	20	65	15
Fish spread	*Fiskepålegg*	10	15	80	32
Other unspesified fish	*Annen uspesifisert fisk*	6	8	88	6
Shellfish and fish offal	*Skalldyr og fiskeinnmat*	5	7	96	13

* The accumulated total intake (in percent) is shown.
** Milk, cream, yoghurt, and other dairy products not including butter and cheese.
*** Cereals, rice, corn products, biscuits, not including cakes and cookies.

Appendix D: Data used to establish the knowledge base

An overview of the data used to establish the knowledge base is given in Table D-1.

Table D-1. The data and approaches used to establish the knowledge base (an Excel file).

Substance	**Quantitative data**		**Qualitative data**			**Unknown sources**
	Reported contribution percentage (Priority 1)	Reported contribution (exposure) (Priority 2)	Reported major contributor (Priority 3)	"Undesirable chemical substance/ food item pairs" identified by ANSES (Priority 4)	Reported possible contributor (Priority 5)	Possible contribution evaluated by expert judgement
Acrylamide	x					x
Aflatoxins	x					x
Alternariol	x					x
Alternariol methyl ether	x					x
Arsenic, inorganic	x					x
Butylated hydroxytoluene	x					x
Cadmium	x					x
Caffeine	x					x
Cyanogenic glucoside	x					x
Dioxin and dioxin-like PCBs	x					x
Deoxynivalenol	x					x
Enniatin	x					x
Ergot alkaloids	x					x
Fumonisins	x					x
Lead	x					x

Substance	Quantitative data		Qualitative data			Unknown sources
	Reported contribution percentage (Priority 1)	Reported contribution (exposure) (Priority 2)	Reported major contributor (Priority 3)	"Undesirable chemical substance/ food item pairs" identified by ANSES (Priority 4)	Reported possible contributor (Priority 5)	Possible contribution evaluated by expert judgement
Nitrates	x					x
Nitrites	x					x
Ochratoxin A	x					x
Perchlorate	x					x
Per- and polyfluoroalkyl substances	x					x
Phosphates	x					x
Pyrrolizidine alkaloids	x					x
Zearalenone	x					x
Polycyclic aromatic hydrocarbons		x				x
Esterified 3- and 2-Monochloropropane-1,2-diol			x			x
Furan			x		x	x
Glycidol from esters			x			x
Methylmercury			x			x
Microcystin			x		x	x
Patulin			x			x
Solanine and chaconine			x			x
T-2 and HT-2 toxin			x			x
Azaspiracids				x		x
Erucic acid				x		x

Substance	Quantitative data		Qualitative data			Unknown sources
	Reported contribution percentage (Priority 1)	Reported contribution (exposure) (Priority 2)	Reported major contributor (Priority 3)	"Undesirable chemical substance/ food item pairs" identified by ANSES (Priority 4)	Reported possible contributor (Priority 5)	Possible contribution evaluated by expert judgement
Aluminium					x	x
Citrinin					x	x
Heterocyclic aromatic amines					x	x
Iodine					x	x
Non-dioxin-like polychlorinated biphenyls					x	x
Tetrodotoxin					x	x
Tin					x	x
Tropane alkaloids					x	x