

Application to exclude Blacklip Rock Oysters from the
maximum level for cadmium in molluscs in the Australia New
Zealand Food Standards Code

**Application submitted to Food Standards Australia New Zealand by the
Department of Agriculture and Fisheries, Northern Territory Government of
Australia.**

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Abbreviations

ATDS	Australian Total Diet Study
ATSDR	Agency for Toxic Substances and Disease Registry (United States)
β2MG	β2-microglobulin
bw	Body weight
CAC	Codex Alimentarius Commission
CCFAC	Codex Committee on Food Additives and Contaminants
EFSA	European Food Safety Authority
FAO	Food and Agriculture Organization of the United Nations
FSANZ	Food Standards Australia New Zealand
JECFA	Joint FAO/WHO Expert Committee on Food Additives
ML	Maximum Level
NAG	<i>N</i> -acetyl-β-glucosaminidase
NTP	National Toxicology Program (United States)
PTMI	Provisional Tolerable Monthly Intake
PTWI	Provisional Tolerable Weekly Intake
TRV	Toxicological Reference Value
US EPA	United States Environmental Protection Agency
US FDA	United States Food and Drug Administration
WHO	World Health Organization

Executive Summary

This application seeks an amendment to the Australia New Zealand Food Standards Code (the Code) to exempt Blacklip Rock Oysters (*Saccostrea spathulata*) from the cadmium maximum level (ML) of 2 mg/kg for molluscs.

Blacklip Rock Oysters are a favoured candidate for aquaculture because they grow relatively quickly to a marketable size, are tolerant of fluctuating growing environment conditions, and have good consumer acceptance. However, the levels of cadmium in Blacklip Rock Oysters from various sites in the Northern Territory typically exceed the Code ML for cadmium of 2 mg/kg, despite low levels of cadmium in seawater, marine sediments and phytoplankton at these sites.

Cadmium levels above 2 mg/kg are also observed in Bluff oysters (also known as dredge oysters) and Queen scallops, and these are both excluded from the Code ML for cadmium.

The Codex Alimentarius General Standard for Contaminants and Toxins in Food and Feed specifies a cadmium ML of 2 mg/kg for marine bivalve molluscs, however the ML does not apply to oysters and scallops. This exclusion for oysters and scallops was supported by Australia during the development of the Codex ML for molluscs. Also, Canada and the USA do not have maximum levels for cadmium in oysters despite the occurrence of cadmium levels above 2 mg/kg at various locations.

No public health and safety concerns are expected from the consumption of Blacklip Rock Oysters that contain cadmium at levels greater than 2 mg/kg. This is due to the low absorption of oyster-derived cadmium, which is likely to be related to the high content of essential minerals (e.g. zinc, iron, calcium) in oysters which compete with cadmium uptake in the body. No adverse health effects have been identified in populations consuming large amounts of other oyster species containing cadmium at levels similar to those in Blacklip Rock Oysters.

Food Standards Australia New Zealand (FSANZ) has previously conducted risk assessments of dietary cadmium for the Australian and New Zealand population groups and concluded there were no public health and safety concerns. In the 2019 Australian Total Diet Study, estimated cadmium dietary exposure for adults at the 90th percentile only reached

~35% of the tolerable monthly intake of 25 µg per kg bodyweight derived by the Joint FAO/WHO Expert Committee on Food Additives (JECFA).

There has been significant investment into development of a Blacklip Rock Oyster aquaculture industry in the Northern Territory driven by Traditional Owners and a local market demand for locally sourced oysters. An established Blacklip Rock Oyster industry has been estimated to create more than 900 direct and indirect regional jobs in Northern Australia within 20 years. Exclusion of Blacklip Rock Oysters from the ML for cadmium in molluscs is considered essential for the development of this industry and no public health and safety concerns are expected from cadmium levels exceeding the current ML in the Code.

General Requirements (Section 3.1.1 of the Application Handbook)

B. Applicant details

(a) **Applicant's name/s**

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(f) **Nature of applicant's business**

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(g) **Details of other individuals, companies or organisations associated with the application**

Application prepared by:

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C. Purpose of the application

This application seeks an amendment to the Australia New Zealand Food Standards Code (the Code) to exempt Blacklip Rock Oysters (*Saccostrea spathulata*) from the cadmium maximum level (ML) of 2 mg/kg for molluscs.

D. Justification for the application

Blacklip Rock Oysters¹ grow from as far west as the Cone Bay in Western Australia to as far east as Bowen in North Queensland (Nowland et al. 2019) and this species has been traditionally harvested for consumption by Indigenous Australians for centuries (Burchert 2016). Blacklip Rock Oysters are a favoured candidate for aquaculture because they grow relatively quickly to a marketable size and have good consumer acceptance. They are also tolerant of fluctuating conditions in their growing environments (Norwood 2021).

However, the levels of cadmium in Blacklip Rock Oysters from various aquaculture sites in the Northern Territory typically exceed the Code ML for cadmium of 2 mg/kg, despite low levels of cadmium in seawater², marine sediments and phytoplankton at these sites (see Section C.2).

Cadmium levels above 2 mg/kg are also observed in Bluff oysters (also known as dredge oysters) and Queen scallops, and these are both excluded from the Code ML as shown in Table 1.

¹ Blacklip Rock Oysters belong to the genus *Saccostrea* and the species has recently been confirmed as *spathulata* (McDougall et al. 2024). They have previously been referred to as *Saccostrea* lineage J (Rennie et al. 2024), *S. mytiloides* (Burchert 2016) and *S. echinata* (CSIRO 2019; Nowland et al. 2019).

² The maximum cadmium level detected in seawater at Blacklip Rock Oyster aquaculture sites in the Northern Territory was 0.027 µg/L, which is well below the limit of 0.5 µg/L specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000). See Section C.2.

Table 1 Maximum levels for cadmium in foods (from Australia New Zealand Food Standards Code, Schedule 19: <https://www.legislation.gov.au/F2015L00454/latest/downloads>)

<i>Contaminant</i>	<i>Food</i>	<i>Maximum level (mg/kg)</i>
Cadmium	Amaranth, grain	0.1
	Chinese cabbage (Pe-tsai)	0.1
	Chocolate and cocoa products	0.5
	Kidney of cattle, sheep and pig	2.5
	Leafy vegetables (as specified in Schedule 22)	0.1
	Liver of cattle, sheep and pig	1.25
	Meat of cattle, sheep and pig (excluding offal)	0.05
	Molluscs (excluding dredge/bluff oysters and queen scallops)	2
	Peanuts	0.5
	Rice	0.1
	Root and tuber vegetables (as specified in Schedule 22)	0.1
	Salt	0.5
	Wheat	0.1

In 2006, Australia successfully advocated that the Codex Alimentarius ML for cadmium in marine bivalve molluscs should not apply to oysters (see Section J.1). Also, Canada and the USA do not have maximum levels for cadmium in oysters (see Section J.2).

No public health and safety issues are expected from the consumption of Blacklip Rock Oysters that contain cadmium at levels greater than 2 mg/kg. This is due to the following:

- i. Cadmium from oysters is poorly absorbed in the body. This is likely to be related to the high content of essential minerals (e.g. zinc, iron, calcium) in oysters which compete with cadmium uptake in the body (see Section B.1).
- ii. No adverse health effects have been identified in populations consuming large amounts of oysters containing cadmium at similar levels to those in Blacklip Rock Oysters (see Section B.3).
- iii. Adverse health effects due to cadmium dietary exposure have only been confirmed in a population consuming a predominantly rice-based diet (i.e. low in essential minerals) for which the rice was contaminated with cadmium from a neighbouring mine (Sakurai et al. 2023).

- iv. Previous risk assessments of dietary cadmium by FSANZ raised no public health and safety concerns. For example, in the 2019 Australian Total Diet Study, estimated cadmium dietary exposure for adults at the 90th percentile only reached ~35% of the tolerable monthly intake of 25 µg per kg bodyweight derived by JECFA (Appendix 1).

If this application is approved only farmed oysters will be permitted for sale under aquaculture licence arrangements. Blacklip Rock Oysters from all Northern Territory sites tested to date have exceeded the cadmium ML and no sites have been excluded from commercialisation consideration due to cadmium levels. Approval of the application would also likely result in the establishment of new aquaculture sites due to the considerable interest from remote communities in Northern Australia in farming Blacklip Rock Oysters.

D.1 Regulatory impact information

D1.1 Costs and benefits of the application

There has been significant investment into development of a Blacklip Rock Oyster aquaculture industry in the Northern Territory driven by Traditional Owners and a local market demand for locally sourced oysters. Tropical oyster farming has been viewed as a priority area for development and has been supported by research and development funding of over \$10 million to date (CRCNA 2023, 2024; NTGOV 2024).

An established Blacklip Rock Oyster industry has been estimated to create more than 900 direct and indirect regional jobs in Northern Australia within 20 years, adding an estimated \$217 million to the economy (CRCNA 2023). These jobs will include farm technicians, trades, processors, distributors, vessel operators and machinery/equipment suppliers. Exclusion of Blacklip Rock Oysters from the maximum level for cadmium in molluscs is considered essential for the development of this industry.

Additional benefits of this application, if approved, include (i) harmonization with the relevant Codex standard and, (ii) achieving internal consistency within the Australia New Zealand Food Standards Code for which another oyster species (Bluff/dredge) is excluded from the cadmium ML due to its natural tendency to concentrate the metal from a low-cadmium marine environment.

D1.2 Impact on international trade

The application is not likely to have an impact on international trade. If Blacklip Rock Oysters are to be exported they must not exceed any maximum level for cadmium set by the importing country.

E. Information to support the application

E.1 Data requirements

Literature searches were conducted to identify studies reporting elevated cadmium levels in oysters, and human studies on cadmium exposure from oyster consumption, including studies investigating bioavailability and safety.

Search terms included “cadmium”, “bioavail*”, “absorption”, “concentration”, “level*”, “oyster*”, “mollusc*”, “shellfish”. Searches were conducted on pubmed and google scholar and were not limited by publication year.

F. Assessment procedure

The General Procedure is considered the appropriate procedure for FSANZ assessment of this application. The nature of this application is consistent with General Procedure Level 4 as described in the FSANZ Application Handbook.

G. Confidential commercial information

The application does not contain information that would be considered Confidential Commercial Information (CCI).

H. Other confidential information

The application does not contain other information that would be considered confidential.

I. Exclusive Capturable Commercial Benefit

This application, if approved, will not confer an Exclusive Capturable Commercial Benefit to the applicant. In addition to the Northern Territory, Blacklip Rock Oysters grow in Western Australia and Queensland. Approval of this application has the potential to commercially benefit a range of stakeholders in a developing Blacklip Rock Oyster industry across northern Australia.

J. International and other national standards

J.1 International standards

The Codex Alimentarius General Standard for Contaminants and Toxins in Food and Feed specifies a cadmium ML of 2 mg/kg for marine bivalve molluscs, however the ML does not apply to oysters and scallops (Table 2) (Codex 2023).

Table 2 Codex ML for cadmium in marine bivalve molluscs

Commodity/ Product name	Maximum level (ML) (mg/kg)	Portion of the commodity/ Product to which the ML applies	Notes/Remarks
Marine bivalve molluscs	2	Whole commodity after removal of shell	The ML applies to clams, cockles, and mussels but not to oysters and scallops.

During the process to develop the Codex cadmium maximum level (ML) for marine bivalve molluscs, Australia advocated that the ML should not apply to oysters. At the 38th session of the Codex Committee on Food Additives and Contaminants (CCFAC 2006), Australia noted that cadmium is a naturally occurring contaminant often found at low levels in seafood, and that low levels of cadmium can be detected in seafood harvested from pristine waters where there is no industrial or agricultural activity. Australia referred to a JECFA evaluation on cadmium for various food groups (leafy vegetables, other vegetables, and molluscs), and recommended that CCFAC discontinue work on the proposed ML for cadmium in molluscs for the following reasons:

- i. JECFA estimated the highest intakes of cadmium at $\leq 5\%$ of the Provisional Tolerable Weekly Intake (PTWI) for these food groups, including molluscs, in all 5 regional diets

- ii. JECFA's intake estimates for these food groups therefore do not meet criteria laid out in the CCFAC policy for Exposure Assessment of Contaminants and Toxins in Foods or Food Groups for setting MLs which was endorsed by the Codex Alimentarius Commission (CAC) in 2005.

Australia further stated that, should CCFAC not discontinue consideration of MLs for cadmium in molluscs, in order to simplify the deliberations whilst protecting human health, CCFAC should consider establishing an ML of 2–3 mg/kg for molluscs but excluding oysters and gastropods.

The Codex Alimentarius Commission (CAC) subsequently adopted an ML of 2 mg/kg for marine bivalve molluscs, excluding oysters and scallops (CAC 2006).

J.2 Other national standards

Maximum levels for cadmium applicable to oysters are specified in regulations in the European Union and in several jurisdictions in Asia (Table 3). The USA has no regulatory levels or guidance for cadmium in fish or fishery products, including oysters (US FDA 2022). Canada has no maximum levels for cadmium in any foods (Health Canada 2005a, 2005b).

Table 3 Cadmium maximum levels applicable to oysters in the European Union and Asian jurisdictions

Jurisdiction	Cadmium maximum level	Reference
European Union	1.0 mg/kg (bivalve molluscs)	EU (2023)
China	2.0 mg/kg (bivalves, viscera removed)	China (2023)
Hong Kong	2 mg/kg (bivalve molluscs)	Hong Kong (2023)
Singapore	1 part per million (molluscs)	SSO (2025)

K. Statutory declaration

A Statutory Declaration is provided as a separate document.

L. Checklist

This application concerns the maximum level of cadmium as a chemical contaminant in oysters. Therefore, the application addresses the following sections of the FSANZ Application Handbook (FSANZ 2024):

- Section 3.1.1 – General requirements
- Section 3.4.1 – Chemical contaminant and natural toxicant maximum levels

The checklists for Sections 3.1.1 and 3.4.1 are included as Appendices 2 and 3.

Chemical contaminant and natural toxicant maximum levels (Section 3.4.1 of the Application Handbook)

A.1 Nature of contaminant

In 2024, the Codex Committee on Contaminants in Foods reviewed cadmium as part of its consideration to develop a Code of Practice for the prevention and reduction of cadmium contamination in foods. The information below was derived from the Codex discussion paper (Codex 2024).

Cadmium is a toxic heavy metal that occurs in the environment both from natural and anthropogenic sources. Exposure to cadmium can occur through ingestion, inhalation, and dermal contact. The organ most sensitive to adverse effects from cadmium exposure is the kidney.

Cadmium is relatively poorly absorbed into the body, but once absorbed it is slowly excreted, with a half-life of 10 to 33 years. Sources of cadmium exposure include food, water, atmospheric deposition (e.g. from burning of fuels, metal smelters), cigarette smoking, occupational exposures, and consumer products (e.g. batteries, paints, coatings, jewellery).

Food is the primary source of cadmium exposure for most people, with the exception of smokers or individuals with occupational exposures. Cadmium presence in food arises from numerous sources including soil, water and air. Cadmium occurs naturally in soil from the weathering of rocks. Soil cadmium also results from mining and smelting operations, sewage sludge, manure, and phosphate fertilizers. Agricultural crops can take up cadmium from the soil. Atmospheric particles of cadmium from soil dust and from industrial activities (e.g. mining) can deposit on plant surfaces (e.g. leafy greens, wheat). Crops and soil containing cadmium are also a source of contamination of livestock who may eat contaminated crops and soil.

Cadmium tends to bioaccumulate in the viscera of seafood. For seafood that is consumed whole, gutting the viscera prior to consumption can reduce cadmium exposure. For example, scallop processors in Greenland may remove scallop kidneys, which can contain high levels of cadmium, before sale.

It was stated that the proposed Code of Practice will address measures, supported by scientific data, that prevent or reduce cadmium contamination. It was stated that measures to be addressed may include agricultural techniques (e.g. fertilization, irrigation), source-directed measures (reduction of cadmium in soil and water), and food processing modifications.

Relevant to this application, attempts to reduce cadmium levels in Blacklip Rock Oysters by relocating high cadmium oysters (mean 5.9 mg/kg) to another site producing oysters with lower cadmium levels (mean 2.2 mg/kg) resulted in only minor changes in cadmium levels in the relocated oysters. Similar results were obtained from depuration trials in which oysters with high cadmium levels were transferred to seawater tanks for 30 days. In contrast, depuration over a 7-month period resulted in cadmium concentration reduction of ~3-fold, however on a commercial scale depuration over such an extended period would not be economically feasible. See section C.2.

A.2 Analytical detection method

WHO (2011) describes analytical methods for the determination of cadmium in foods. Detection techniques include various types of atomic absorption spectrometry (AAS), atomic fluorescence spectrometry (AFS), inductively coupled plasma optical emission spectrometry (ICP-OES) and inductively coupled plasma mass spectrometry (ICPMS).

Analysis of cadmium in Blacklip Rock Oysters has been conducted using an ICPMS method and included analyses of certified reference material 1566b (freeze-dried oyster tissue) from the National Institute of Standards and Technology (USA) (Munksgaard et al. 2017).

B.1 Toxicokinetics & metabolism information

Animal and human toxicokinetics studies on cadmium have been evaluated on several occasions by JECFA (WHO 1972, 1989, 2001, 2004, 2011). Information in the summary below is derived from the JECFA assessments and from a more recent review (Nordberg et al. 2018). Human studies on cadmium intake from oysters are also summarised.

B1.1 Absorption

The bioavailability of cadmium from the gastrointestinal tract is generally considered to be slightly lower in experimental animals than in humans. For the majority of animal species tested, cadmium absorption ranges from 0.5% to ~3% of the administered dose, while in humans a range of 3–10% has been found.

Absorption has been shown to be influenced by dietary intake of iron, calcium and zinc. Such interactions are explained by the fact that cadmium utilizes the same intestinal transporters as these metals. In humans, cadmium absorption from the diet has been shown to be particularly influenced by iron status, with up to four-fold higher uptake when serum ferritin is below 20 µg/L, leading to higher cadmium values in blood or urine in women with low iron stores. Absorption has also shown to be influenced by dietary intake of protein, carbohydrate and fibre.

There is evidence that cadmium in oysters is particularly inefficiently absorbed. Sharma et al. (1983) and McKenzie-Parnell et al. (1988) describe a study in which subjects habitually consumed large quantities of oysters (up to 72 or more per week) containing cadmium at a mean level of 5.7 mg/kg, which is almost 3-times the maximum level of 2 mg/kg in the Australia New Zealand Food Standards Code. After 6 months of oyster consumption, faecal output of cadmium correlated well with oyster consumption level and the concentrations of cadmium in urine and hair were unaffected by oyster consumption. A slight increase in blood cadmium was observed in the highest oyster consumers. Additional information from this study is presented in Section B.3 (Human studies related to safety).

Vahter et al. (1996) investigated the dietary intake and uptake of cadmium in nonsmoking women, 20–50 years of age, consuming a diet low in shellfish (n = 34) or a diet including shellfish once a week or more (n = 17). Duplicate diets were collected during 4 consecutive days for the determination of cadmium content. The high shellfish diet (median 22.3 µg cadmium/day) provided twice as much cadmium as the low shellfish diet (median 10.5 µg cadmium/day). Cadmium in faeces corresponded to ~99% of the cadmium derived from each diet, indicating negligible cadmium absorption. There was no statistically significant difference between groups in the concentrations of cadmium in blood or urine.

Copes et al. (2008) report that Pacific Oysters along the North American coast from Washington to Alaska contain concentrations of cadmium frequently exceeding 2 mg/kg. To determine the effect of oyster consumption on cadmium in blood and urine in a population

group with high oyster consumption, 61 non-smoking oyster growers and family members with a mean age of 47 years (range 33–64) were interviewed by telephone to assess their oyster consumption and other sources of cadmium exposure at present and 5 years prior to the start of oyster farming. Recent and long-term oyster consumption was a positive predictor of blood cadmium but did not predict urine cadmium.

B1.2 Distribution and metabolism

Absorption of cadmium from the gastrointestinal tract is characterized by a rapid initial uptake into the intestinal mucosa, followed by a slower absorption into the systemic circulation and distribution to kidney and liver. In humans, about 50% of the cadmium body burden is found in kidneys. Other major organs/tissues contributing to body burden include the liver (15%) and muscle (20%).

Transport of cadmium from the small intestine is thought to be facilitated by a number of possible mechanisms, including metal transport proteins, calcium ion channels, amino acid transporters and by endocytosis of cadmium–metallothionein complexes. Binding to metallothionein is thought to allow the liver to accumulate cadmium without exhibiting adverse effects.

B1.3 Excretion

After oral exposure, most cadmium (up to 90% in experimental animals) passes through the gastrointestinal tract unabsorbed and is excreted in the faeces. Cadmium that is absorbed is excreted slowly, resulting in a long half-life in the body, with estimates ranging between 10 and 33 years in humans. A portion of the retained and absorbed cadmium can also be excreted via the faeces after hepatic secretion of cadmium conjugates (e.g. with glutathione) into the bile. When cadmium is administered at a low dose, a minor fraction can also be excreted in the urine (as metallothionein–cadmium). However, at doses sufficient to induce nephrotoxicity, greater amounts of unfiltered cadmium are eliminated in the urine due to declining renal filtration capacity as a consequence of tubule damage.

B.2 Toxicity studies

A large number of in vitro toxicity studies and toxicity studies in laboratory animals have been evaluated by JECFA on several occasions (WHO 1972, 1989, 2001, 2004, 2011) and by the International Programme on Chemical Safety (WHO 1992) and the major findings are summarised in section B.2.1. Only a brief summary is provided because JECFA used extensive human data to derive a tolerable intake for cadmium (WHO 2011); see section B.3) and the JECFA tolerable intake was used by FSANZ in its 2019 cadmium risk assessment conducted for the 25th Australian Total Diet Study (ATDS; see Appendix 1). Several other agencies have also derived cadmium tolerable intakes from human data (see section B.3).

A recent systematic review of animal and human studies has been published by the United States Food and Drug Administration (US FDA; Schaefer et al. 2022). Information relevant to animal studies is summarised in Section B.2.2.

B.2.1 Summary of JECFA/WHO assessments

Acute toxicity

Oral LD50 values from animal studies (mainly rodents) range from approximately 100 to 300 mg/kg bodyweight (bw) and are dependent on the form of cadmium administered. For example, the LD50 for cadmium sulfide, which is of very low water solubility, is approximately 10-fold greater than the LD50 for the highly water-soluble compound CdCl₂. At oral doses near the LD50, histopathological evidence of liver toxicity (fibrosis, necrosis) is a common finding, as is testicular atrophy and necrosis with subsequent decreased fertility.

Short-term toxicity

Numerous short-term studies have been performed, mainly aimed at investigating the pathogenesis of kidney lesions and the critical levels of cadmium associated with adverse effects in the renal cortex. However, the results are not always readily interpretable since renal cadmium levels decline with the onset of proteinuria.

Long-term toxicity and carcinogenicity

Long-term oral administration of cadmium compounds to laboratory animals produces effects primarily on the kidneys, but also on the liver and the haematopoietic, immune, and skeletal system at higher doses. A variety of progressive histopathological changes in the kidney are observed, including epithelial cell damage of proximal tubules, interstitial fibrosis and glomerular basal cell damage with limited tubular cell regeneration. Biochemical indications of renal damage were seen in the form of low molecular weight proteinuria, glucosuria and aminoaciduria. Tubular dysfunction also causes an increase in the urinary excretion of cadmium.

Studies in experimental animals treated by injection or inhalation have provided considerable evidence that cadmium is carcinogenic. In rats, cadmium causes a variety of tumours, including malignant tumours at the site of injection, and in the lungs, after inhalation. Oral intake is associated with proliferative lesions of the ventral lobe of the prostate gland in rats fed diets that are adequate in zinc, whereas deficiency in zinc in the diet appears to inhibit the tumorigenic effect of cadmium. JECFA stated that the relevance of these studies to carcinogenesis in the human prostate gland is questionable, because of anatomical differences between the prostate gland in humans and that in rodents. JECFA concluded that (i) cadmium is carcinogenic in experimental animals when given by injection or inhalation, (ii) workers exposed by inhalation have been shown to develop lung cancer, and (iii) there was no evidence that cadmium is carcinogenic to humans exposed orally.

Genotoxicity

Equivocal results have been obtained when cadmium is tested for its ability to cause gene mutations in a variety of prokaryotic and mammalian cells. Cadmium induces chromosomal aberrations in both human and rodent cells, but the evidence suggests that the mechanism is not one of direct genotoxicity.

Reproductive and developmental toxicity

In reproductive and developmental toxicity studies in rodents, no teratogenic effects were reported after oral intake of low doses of cadmium compounds. In contrast, high doses (far exceeding human exposure levels) have induced testicular atrophy, severe placental damage and fetal death, while teratogenic effects have included exencephaly, hydrocephaly, cleft lip and palate, microphthalmia, micrognathia, and club foot. JECFA concluded there are no indications of adverse effects on reproduction and embryofetal development in humans exposed to cadmium.

B.2.2 US FDA systematic review of animal studies

The US FDA recently published a systematic review of animal and human studies on cadmium (Schaefer et al. 2022). The authors followed the US National Toxicology Program systematic review framework (NTP 2019). A subsequent publication by the US FDA described the derivation of separate tolerable intake values from the human data and the animal data (Schaefer et al. 2023).

A literature search for studies published up to 4 January 2020 resulted in 103 animal studies considered eligible for quality assessment and data extraction. The authors concluded that the endpoints providing high confidence in the relationship between oral cadmium exposure and adverse effects were kidney (renal pathology and dysfunction; 6 studies) and bone mineral density/mechanical strength (13 studies). Three of the kidney studies and two of the bone studies were concluded to be of high quality and low risk of bias. These five studies were conducted in rats. Using benchmark dose modelling and applying uncertainty factors of 100 for the bone data and 300 for the kidney data, toxicological reference values (TRV; equivalent to a tolerable intake) of 0.63 and 1.8 µg/kg bw per day, respectively, were derived. The lower of these values is similar to the JECFA tolerable intake when expressed as a daily value (0.8 µg/kg bw per day; see section B.3) (WHO 2011).

The authors concluded there was a moderate degree of confidence in the evidence for cardiovascular, hematology, development, neurological, and tissue adverse effects. Also, these effects occurred at higher doses than those resulting in bone or kidney effects and the number of available studies was limited. The evidence related to cancer (oral exposure), gastrointestinal/ metabolism, immune/skin and reproductive endpoints was considered to be of low confidence based on limited studies and consistency.

B.3 Human studies relevant to safety

A large number of human studies on cadmium have been considered by JECFA on several occasions (WHO 1972, 1989, 2001, 2004, 2011). As summarised below, JECFA used extensive human data on urine levels of cadmium and a biomarker of kidney damage to derive a Provisional Tolerable Monthly Intake (PTMI) for cadmium (WHO 2011) and this PTMI was used by FSANZ in its risk assessment for the 25th Australian Total Diet Study (ATDS), conducted in 2019 (see Appendix 1 for a summary).

The following agencies have also derived cadmium tolerable oral intake values using human data: the US Environmental Protection Agency (US EPA 1989), the European Food Safety Authority (EFSA 2009b), the US Agency for Toxic Substances and Disease Registry (ATSDR 2012) and, most recently, the US FDA (Schaefer et al. 2022, 2023). The US FDA assessment is summarised in section B.3.2.

B.3.1 JECFA tolerable intake derivation from human studies

JECFA last considered cadmium in 2010 and, based on a meta-analysis of human studies (conducted by EFSA), derived a PTMI of 25 µg/kg bodyweight (WHO 2011). The tolerable intake is expressed on a monthly basis, rather than daily or weekly, due to the long half-life of cadmium in the body.

JECFA concluded that the kidney is the critical organ in humans exposed for long periods to the amounts of cadmium typically present in food, and many human studies have investigated associations between biomarkers of exposure (e.g. urine and blood cadmium levels) and biomarkers of renal effects [e.g. urine levels of β₂-microglobulin (β₂MG) and retinol binding protein). JECFA also stated that the overall evidence points to an association between urinary cadmium and a decrease in bone mineral density, but that it is unclear whether the effect is secondary to renal tubular dysfunction and the data do not provide a basis for a dose-response analysis.

JECFA considered that although there is good evidence to indicate a relationship between the urinary excretion of cadmium following renal damage and various renal biomarkers, especially from occupational exposure, the health significance of these nonspecific biomarkers in relation to renal damage in the general population remains uncertain. It was also stated that effects on these biomarkers might reflect an early renal response to cadmium, which may be adaptive or reversible in nature. Alternatively, it was stated that observed associations between elevated protein in urine and levels of cadmium in urine might simply be a result of a co-excretion of markers of exposure and effect (i.e. the association may not be causal).

JECFA considered an EFSA meta-analysis of 35 published studies to determine a dose-response relationship between urine β₂MG and urine cadmium levels (EFSA 2009a). Urine β₂MG was chosen as the most suitable biomarker for the meta-analysis because it is widely recognized as a marker for renal pathology (Griffin et al. 2019) and had the largest number

of available data. The 35 studies included approximately 30,000 predominantly non-occupationally exposed individuals (99%). The majority of these individuals were of Asian descent (93.5%) and female (75%).

Due to the long half-life of cadmium in the body, steady state concentrations of cadmium in kidney are achieved by age 45–60 years. Therefore, JECFA considered that data for the population sub-group ≥ 50 years of age provide the most reliable basis on which to determine a critical concentration of cadmium in urine. The analysis for the population aged 50 years and over showed that a urinary excretion of less than 5.24 μg of cadmium per gram creatinine was not associated with increased excretion of $\beta_2\text{MG}$. Higher urinary cadmium levels were associated with a steep increase in $\beta_2\text{MG}$ excretion.

A toxicokinetic model was then used to determine a corresponding dietary exposure that would result in a urine cadmium concentration of 5.24 $\mu\text{g/g}$ creatinine (the “breakpoint”). The lower bound of the 5th percentile dietary cadmium exposure that equates to the breakpoint was estimated to be 0.8 $\mu\text{g/kg}$ bw per day or about 25 $\mu\text{g/kg}$ bw per month, and this value was established as the PTMI.

B.3.2 US FDA systematic review of human studies

The US FDA recently published a systematic review of animal and human studies on cadmium (Schaefer et al. 2022). The aim of the systematic review was to identify adverse health effects reported in animal and human studies and to develop a dose-response relationship for dietary cadmium. The outcomes of the systematic review were used to inform the derivation of tolerable intake values for cadmium (referred to by the US FDA as toxicological reference values; TRVs) (Schaefer et al. 2023).

Human studies investigating the following were excluded from the review: (i) occupational exposure, (ii) exposure from contaminated industrial or environmental sites, and (iii) routes of exposure other than oral (i.e. dermal or inhalational). All health endpoints were considered. The authors followed the US National Toxicology Program systematic review framework (NTP 2019). A literature search for studies published up to 4 January 2020 resulted in 105 human studies considered eligible for quality assessment and data extraction.

Kidney

There were 41 studies examining kidney endpoints/biomarkers and the authors summarised studies investigating the two most studied urine biomarkers of kidney damage, namely β 2MG (24 studies) and *N*-acetyl- β -glucosaminidase (NAG; 14 studies). The authors considered there was a moderate degree of confidence in the body of evidence for the association between dietary cadmium exposure and proximal tubular cell injury as indicated by an increase in NAG in urine, however only one study (Åkesson et al. 2005) was concluded to be of high quality and low risk of bias. For urine β 2MG, two of the three studies assessed to be of low risk of bias found no association between urine β 2MG and urine cadmium, therefore, in contrast to the assessments conducted by EFSA and JECFA, β 2MG was not considered in the dose-response assessment conducted by the authors.

Bone

There were 14 studies investigating bone endpoints and the authors concluded there was a moderate degree of confidence that exposure to cadmium is associated with decreased bone mineral density, however only one study (Engström et al. 2011) was considered to be of high quality and low risk of bias. The authors concluded it was difficult to determine the lowest cadmium exposures associated with decreased bone mineral density because of variable findings and potential confounding and therefore it was not possible to define a no-effect level for this endpoint.

Derivation of a toxicological reference value range from human data

Using benchmark dose modelling of the kidney and bone data published by Åkesson et al. (2005) and Engström et al. (2011), respectively, the US FDA derived a TRV range of 0.21–0.36 μ g/kg bw per day (Schaefer et al. 2023). These values are substantially lower than the TRV range derived by the US FDA from animal data (0.63–1.8 μ g/kg bw per day; see section B.2.2) and the JECFA PTMI, when expressed as a daily value (0.8 μ g/kg bw per day).

It has been noted that associations observed between low levels of urine cadmium and increases in urinary protein excretion may not be causal, partly because urine cadmium at low levels is an uncertain indicator of cadmium concentrations in the kidney cortex (Bernard 2016; Nordberg et al. 2018). It has also been proposed that normal physiological variability in renal reabsorption of low molecular weight proteins, such as β 2MG, causes an increase in urinary cadmium by inhibiting tubular uptake of metallothionein-bound cadmium (Chaumont et al. 2012). Such associations may therefore represent reverse causality. The JECFA PTMI, which is based on an analysis showing that a urinary excretion of less than 5.24 μ g of cadmium per gram creatinine (a level which was not associated with increased excretion of

β 2MG), is considered sufficiently conservative and therefore appropriate for use in dietary risk assessment.

Other health outcomes

Conclusions for endpoints other than those related to kidney or bone were summarised in a supplementary document to Schaefer et al. (2022), as follows:

Cancer (23 studies): The authors concluded there was inadequate epidemiological evidence to support an association between dietary cadmium exposure and an increased risk of various types of cancer.

Cardiovascular (14 studies): The studies primarily investigated relationships between cadmium in blood and/or urine and the increased risk of stroke, myocardial infarction, carotid plaques, blood pressure, and heart failure. Some studies also investigated risks of aortic aneurysm, changes in lipid profiles, and changes in cardiovascular-associated proteins. Overall, the evidence suggests that most studies with a positive association are related to blood levels of cadmium. However, blood cadmium levels do not necessarily reflect chronic dietary exposure levels, therefore the scientific evidence supporting cardiovascular risks and chronic exposure to dietary cadmium was considered by the authors to be weak.

Reproductive endpoints (5 studies): Three of the five epidemiology studies indicated that maternal cadmium exposure may be associated with decreased birth weight, however the authors concluded that use of the studies is limited because of weaknesses in study design (i.e. cross-sectional, single blood samples, single spot urine samples) and lack of control for confounding factors. In addition, the evidence did not support an association of cadmium exposure and high blood pressure in pregnancy.

Endocrine endpoints (4 studies): Due to the limited evidence and inconsistency in the associations supporting endocrine effects and exposure to dietary cadmium, the overall confidence in endocrine effects was considered to be low.

Iron deficiency anaemia (2 studies): The evidence supporting the relationship between dietary cadmium exposure and anaemia in humans is conflicting and the value of the two studies was considered to be limited due to study design (i.e. cross-sectional) and the lack of adjustment for key confounding factors such as occupational exposure.

Neurodevelopment (2 studies): Increased urine cadmium was associated with decreased performance on various neurocognitive tests, however the authors concluded that use of the studies is limited due to the study design and inadequate adjustment for confounding factors.

Hyperuricemia (1 study): Increased blood cadmium was associated with increased serum uric acid in men, however the authors concluded that the value of the study is limited due to study design, lack of adjustment for confounding variables, and the use of blood cadmium (rather than urine cadmium) as a biomarker for chronic dietary exposure.

B.3.3 Studies on high cadmium intake from oyster consumption

Three publications describe an observational study on 75 adults involved in the oyster industry in Bluff, Southland, New Zealand (McKenzie et al. 1986; McKenzie-Parnell et al. 1988; Sharma et al. 1983). It was stated that the concentrations of cadmium in Bluff oysters (*Tiostrea lutaria*) are sufficiently high (mean of 5.7 mg/kg wet weight, see below) such that ingestion of one oyster can more than double the normal daily dietary cadmium intake. The aim of the study was to determine (i) cadmium concentrations in blood, urine, faeces and hair of the study subjects, and (ii) any adverse health effects that could be attributed to cadmium dietary exposure.

Samples of faeces, blood, overnight urine, and hair were collected from subjects both before the commencement of the oyster season and at the end of the season, six months later. Faeces were analysed for cadmium, zinc, copper, and manganese. Urine was analysed for pH, specific gravity, cadmium, zinc, creatinine, urea, glucose, protein, and β 2MG. Blood was analysed for packed cell volume, haemoglobin, cadmium, selenium, zinc, copper, and β 2MG. Hair was analysed for cadmium, zinc, and copper.

Medical and dietary questionnaires (including oyster consumption) were administered at the end of the season when height, weight and blood pressure were measured. Dietary history was evaluated for energy, protein, calcium, zinc, and iron.

Pre-season intakes of cadmium, selenium, zinc, copper, and manganese were reported to be normal for a New Zealand adult not consuming Bluff oysters. Bluff oysters analysed during the season had a mean cadmium content of 27 mg/kg dry weight (equivalent to 5.7 mg/kg wet weight, which is almost 3-times the ANZ Food Standards Code maximum level of 2 mg/kg).

All subjects appeared to consume adequate to generous intakes of energy, protein, calcium, zinc, and iron, in concordance with the usual dietary habits of New Zealand residents at the time.

Average weekly oyster consumption was associated with end-season faecal output of cadmium (Table 4). The highest individual daily faecal excretion of cadmium was 580 µg, which is equivalent to ~10x the JECFA tolerable intake. Faecal output of selenium was also increased in high oyster consumers, but outputs of zinc, copper and manganese were not.

Table 4 Oyster consumption and faecal cadmium output from a study on 75 adults

Oyster consumption category	No. of oysters consumed per week	No. of subjects	End-season faecal cadmium output, mean ± SD (µg/day)
I	0 – 5	18	15 ± 8
II	6 – 23	23	84 ± 134
III	24 – 71	23	129 ± 144
IV	≥ 72	11	233 ± 185

The mean blood cadmium levels for the four oyster intake groups, pre-season and end-season are shown in Table 5. The highest oyster intake group IV had a tendency for higher levels at pre- as well as end-season than the lowest intake group I. However, there were only small differences between the results from the two sampling times in any group, particularly when the high inter-individual variation in each group is taken into account.

Table 5 Blood cadmium levels for subjects who gave samples both pre-season and end-season

Oyster consumption category	No. of subjects	Pre-season blood cadmium, mean ± SD (µg/L)	End-season blood cadmium, mean ± SD (µg/L)
I	9	3.1 ± 2.3	3.4 ± 2.1
II	16	2.7 ± 2.1	2.9 ± 1.8
III	18	3.6 ± 2.5	4.7 ± 2.8
IV	4	5.4 ± 2.4	5.6 ± 1.5

The concentrations of cadmium, zinc and β2MG in urine were unaffected by oyster consumption and there was no indication of glycosuria. Hair cadmium, zinc and copper also

appeared to be unaffected by oyster consumption. There were no indications of any medical problems attributable to high cadmium intake.

C.1 List of foods where maximum level is proposed

This application seeks an amendment to the Australia New Zealand Food Standards Code such that Blacklip Rock Oysters are exempt from the cadmium maximum level of 2 mg/kg for molluscs, as is the case for dredge/bluff oysters and queen scallops.

C.2 Survey data on contaminant or toxicant levels in foods

C.2.1 Cadmium levels in Blacklip Rock Oysters

Fleming et al. (2015) reported cadmium levels from Blacklip Rock Oysters harvested from four sites (8-21 oysters per site) at South Goulburn Island which is 280 km northeast of Darwin, Northern Territory. Oysters were harvested in 2012 and 2013. Wild caught oysters were sampled from sites 1, 2 and 4, and farmed oysters were sampled from sites 1, 2 and 3.

Cadmium was quantified using Inductively Coupled Plasma Mass Spectrometry (ICPMS) in oysters, seawater, seawater total suspended solids, and in a phytoplankton bloom which appeared near sites 1 and 2. Quality control measures included analysis of blank digests, certified reference materials, replicate digests and metal-spiked digests.

Mean cadmium levels in wild caught oysters from the three sites were 4.0, 5.1 and 3.3 mg/kg (wet weight³). For farmed oysters the mean levels were 2.0, 2.5 and 1.4 mg/kg. The farmed oysters were deployed for ≤12 months and were on average half the size of the wild oysters – they therefore had less time to accumulate cadmium compared to the wild oysters.

Trace element levels in seawater at all sites did not exceed the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) and at most sites levels of cadmium, zinc and copper were close to or below the detection limit. The maximum cadmium level detected in seawater was 0.027 µg/L which is well below the ANZECC limit of 0.5 µg/L. Cadmium levels were similar in total suspended solids (mean levels 0.1–0.3 mg/kg) and in the algal bloom (mean level 0.15 mg/kg).

³ In this section, all concentrations in oysters are expressed as wet weight unless stated otherwise.

Burchert (2016) reported that Blacklip Rock Oysters harvested at three sites (3 oysters per site) at South Goulburn Island (NT) showed an almost 3-fold variation in mean cadmium levels (Mardbalk: 2.2 ± 0.4 , Fletchers Point: 2.7 ± 0.6 , Wigu: 5.9 ± 0.4 mg/kg). Oysters were harvested in 2015 and 2016. Cadmium was quantified using an ICPMS method and quality control measures included analysis of blank digests, certified reference materials, replicate digests and metal-spiked digests. Analysis of seawater at the three sites showed similar concentrations of cadmium (mean values of 0.021–0.024 $\mu\text{g/L}$) which are well below the ANZECC limit of 0.5 $\mu\text{g/L}$.

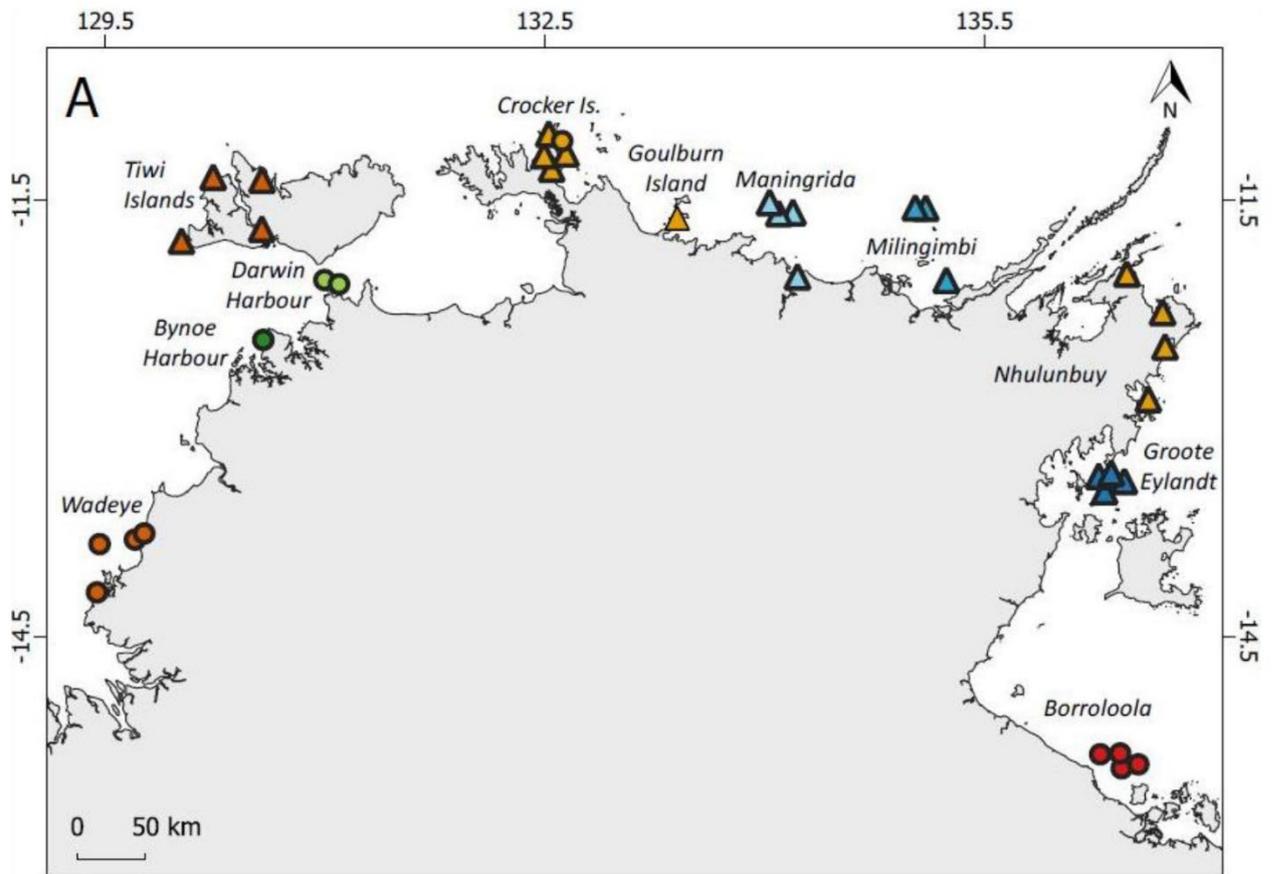
Zinc, which competes with cadmium uptake in oysters, was also at similar levels in seawater at the three sites. In contrast, analysis of marine sediment showed relatively higher zinc levels in the $<20 \mu\text{m}$ fraction at Mardbalk (where oyster cadmium levels were lowest), consistent with preferential uptake of zinc versus cadmium when sediment concentrations of zinc are higher. It was suggested that the higher sedimentary zinc levels may be due to algal bloom debris.

Attempts to reduce oyster cadmium levels by relocating oysters grown at Wigu to the Mardbalk site were unsuccessful. Similarly, depuration trials in which oysters with high cadmium levels were transferred to seawater tanks for 30 days did not reduce cadmium levels despite the addition of a soluble metal chelator (Na_2EDTA). In contrast, over a 7-month period cadmium concentration decreased ~ 3 -fold (from 6.0 to 1.9 mg/kg), however on a commercial scale depuration over such an extended period would not be economically feasible.

Munksgaard et al. (2017) summarises the above two studies and discusses factors that could contribute to elevated cadmium levels in Blacklip Rock Oysters. They conclude that metal levels in seawater were not correlated with cadmium levels in oysters, and suggest that oysters accumulate cadmium mainly from annual phytoplankton blooms, except at sites where zinc availability is sufficiently high to prevent uptake through a mechanism of antagonistic exclusion.

A report by the Northern Territory Department of Industry, Tourism and Trade includes a summary of cadmium levels in wild (not farmed) Blacklip Rock Oysters from 22 sites in the Northern Territory, excluding South Goulburn Island (Figure 1) (DITT 2024). Milky oysters (*Saccostrea scyphophilla*, also known as *Saccostrea mordax*) sampled from 14 different sites were also analysed. Nine oysters (three oysters pooled per sample and three replicates per site) were collected at each of the 36 sites. Oysters were harvested from 2019 to 2021 and were preferentially selected to closely match the size of a market-sized farmed oyster (approximately 70 mm in length).

Cadmium levels in Blacklip Rock Oysters were highly variable between sites, with mean values ranging from 2.8 to 11.2 mg/kg, excluding a substantially lower mean of 0.3 mg/kg at one site, however this may be an outlier due to possible species misidentification (Table 6). The median of these means is 5.5 mg/kg. Mean cadmium levels in milky oysters ranged from 0.4 to 4.7 mg/kg.



Legend

Species		Sampling Period	
○ Milky	△ Black Lip	● March 2019	● February 2021
○ Wild	○ Farmed	● October 2019	● March 2021
		● December 2019	● April 2021
		● August 2020	● June 2021
		● December 2020	● July 2021

Figure 1 Blacklip Rock Oyster and milky oyster sampling sites across the Northern Territory. Legend indicates oyster species sampled, oyster type (wild or farmed) and sampling month and year.

Table 6 Mean cadmium levels in Blacklip Rock Oysters sampled from 22 sites in the Northern Territory from 2019 to 2021

Location	Sampling site	Mean cadmium level (mg/kg)
Nhulunbuy	Dolphin Rocks	3.8
	Yiniwuy	4.8
	Guku Island	11.2
	Barrkira	6.8
Croker Island	Long Reef	8.6
	White Cliff	10.7
	Big Creek	8.8
Groote Eylandt	Hanging Rock	4.6
	Little Jagged	5.5
	Winchelsea Island	3.0
	Tamarind Passage	2.9
Milingimbi	Murrunga East	9.8
	Murrunga West	5.6
	Langarra	4.4
Maningrida	Crab Creek	6.0
	Outstation	7.5
	First Point	5.4
	Rolling Bay	5.8
Tiwi Islands	Mindiloo	0.3
	Cape Fourcroy	3.2
	Walama	2.8
	Mudlow island	2.8

C.2.2 Cadmium levels in Bluff oysters

The cadmium levels reported for Bluff oysters (*Tiostrea lutaria*, also known as dredge oysters), which are exempt from the Code maximum level for cadmium, are similar to the levels in Blacklip Rock Oysters. McKenzie-Parnell et al. (1988) describe an observational study on adults involved in the oyster industry in Bluff, Southland, New Zealand. Bluff oysters (n = 72) analysed for this study had a mean cadmium content of 5.7 mg/kg (see Section B.3 for a summary of this study).

Nielsen (1975) reported cadmium levels of up to 9 mg/kg in Bluff oysters sampled from 24 sites in Foveaux Strait, New Zealand, while Nielsen and Nathan (1975) reported a mean cadmium level of 3.9 mg/kg (range 0.1 to 7.1 mg/kg) in Bluff oysters from other locations in New Zealand.

C.2.3 Cadmium levels in bivalves from Canada

Elevated cadmium levels have also been reported in the Pacific Oyster (*Crassostrea gigas*) which is the most commercially important oyster species globally.

Bendell (2009) reported cadmium levels in Pacific Oysters from the Pacific Northwest, Canada. Cadmium concentrations were generally above 2 mg/kg (range = 1.5–3.6 mg/kg). Of the various shellfish analysed in this study, four species of scallops contained the highest concentrations of cadmium (range = 5.0–9.0 mg/kg), while mussels (*Mytilus* spp.) had cadmium concentrations between 0.4 and 4.0 mg/kg.

Fisheries and Oceans Canada (2010) reports survey data on cadmium levels in Pacific Oysters collected around Vancouver Island, Canada, in 2004/05. Mean cadmium levels ranged from 1.2 to 3.6 mg/kg.

C.3 Information on levels of consumption

An unpublished report by FSANZ describes dietary exposure calculations for cadmium using concentration data from Blacklip Rock Oysters collected from various sites in the Northern Territory (FSANZ 2021). The report refers to oyster consumption levels derived from the 2011-12 Australian National Nutrition and Physical Activity Survey (ABS 2013), as follows:

- On any single day, median and 90th percentile oyster consumption is 6 and 12 oysters, respectively. (Note that this is consistent with the common consumer practice of ordering either half a dozen or a dozen oysters when oysters are chosen for consumption).
- When surveyed over two days, mean consumption is only around 2 oysters. (This large decrease relative to the single day value, above, reflects that oysters are typically not chosen for consumption on consecutive days by the average consumer).

FSANZ (2019) describes a cadmium risk assessment which was conducted as part of the 25th Australian Total Diet Study (ATDS). Appendix 9 of the report cites mean mollusc consumption for all respondents from the 2011–2012 NNPAS as being no more than 0.8 g per person per day, while mean mollusc consumption for consumers (i.e. those survey participants that reported consuming molluscs) was no more than 23 g per person per day.

A recent survey conducted in New Zealand reported average shellfish consumption (all shellfish, not just oysters) of only 4.8 g/day (Guy et al. 2021). This publication also cites the daily average from the most recent New Zealand National Nutrition Survey (NZNNS) data (2008–2009) which was 85 g/day, i.e. more than 17-times higher than 4.8 g/day. The NZNNS is based on a 24-h recall method which only captures short-term dietary recall (as was done for the Australian survey cited in the FSANZ document), while the New Zealand survey is a food frequency questionnaire, which was used because assessment of possible exposure to environmental contaminants requires gathering data on long-term consumption. The authors make the important point that estimation of long-term consumption from 24-h dietary recall can be problematic, particularly when foods of interest are consumed by the majority of the population only occasionally, as is the case for oysters.

In 2021, estimated (“apparent”) consumption of oysters in Australia was reported as 0.5 kg per person, equivalent to 1.5 g/day (ABARES 2022). Total apparent consumption was calculated as the sum of edible production and edible imports, less edible exports. The apparent consumption per person was calculated as the total apparent consumption divided by the total Australian population in each year. For comparison, annual apparent consumption of total seafood was 13.8 kg per person, or 38 g/day.

C.4 Where consumption has changed, information on likely consumption

Over the period 1999 to 2021, annual apparent oyster consumption in Australia peaked in 2007 at 0.8 kg/person before declining to 0.4–0.5 kg/person for each year since 2013 (ABARES 2022).

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Appendix 1

Cadmium risk assessments by FSANZ

FSANZ conducted a risk assessment for cadmium as part of its consideration of an application to increase the cadmium ML for peanuts from 0.1 mg/kg to 0.5 mg/kg (FSANZ 2008). FSANZ used the Provisional Tolerable Weekly Intake (PTWI) of 7 µg/kg bw which was the JECFA value at the time. FSANZ noted that the toxicological significance of the observed association of elevated urine protein with respect to kidney damage is still not established, as urinary protein excretion normally increases with age. FSANZ also noted that the PTWI was established based on cumulative intake. Thus, intake above the PTWI may be tolerated provided it is not sustained for long periods of time and does not produce a significant increase in the integrated life-time dose.

Major food contributors to total cadmium dietary exposure for the Baseline scenario included potato for all Australians as well as cacao beans (chocolate) for those 2-6 years, and potato and mussels for New Zealand. For the Proposed ML scenario, these foods, together with peanuts were also major contributors to total cadmium dietary exposure for the respective population groups.

Oyster consumption was estimated to contribute only 1–3% of total cadmium dietary exposure. The cadmium concentration for oysters used in this dietary exposure assessment was 0.49 mg/kg (derived from an unpublished survey).

It was stated that the exposure estimates for all population groups are likely to be overestimates because it was assumed that all peanuts contain cadmium at 0.5 mg/kg, which is extremely unlikely as the available data on cadmium levels in peanuts indicates that most peanuts will have cadmium concentrations well below this level. It was also stated that the data used for modelling is a 24-h record which overestimates food consumption for consumers as they are unlikely to consume the same foods in the same quantities every day (the use of multiple day records tends to significantly reduce predicted high consumer exposure).

Modelling of total dietary exposure to cadmium from all dietary sources, including an increase in the ML for cadmium in peanuts to 0.5 mg/kg, indicated that Australian and New Zealand consumers would have cadmium dietary exposures below the PTWI. For example, 90th percentile dietary exposure for the population group with the highest dietary exposure was 75% of the PTWI. It was concluded that increasing the ML for cadmium in peanuts from 0.1 to 0.5 mg/kg would not raise public health and safety concerns.

FSANZ conducted a cadmium risk assessment as part of the 25th Australian Total Diet Study (ATDS) (FSANZ 2019). Cadmium was detected in 43 of the 88 foods analysed (note that oysters were not analysed in this study) and estimated dietary exposures were compared to the JECFA PTMI of 25 µg/kg bw.

Major dietary contributors to cadmium exposure were root vegetables, savoury snacks including crisps, grain type breads, cakes and baked goods, and berries.

Dietary exposures were below the PTMI for all population subgroups assessed, except for the 90th percentile for infants aged 9 months, for which there was a slight exceedance (130%) at the upper bound of the dietary exposure estimate. It was stated that this temporary exceedance is not considered to be of concern due to the highly conservative method of dietary exposure assessment used and the nature of potential health effects which would only be associated with high levels of long-term exposure over many years. Adults aged 19 years and above (the population group most relevant to oyster consumption) had the lowest mean and 90th percentile dietary exposures to cadmium (90th percentile dietary exposure only reached ~35% of the PTMI).

Appendix 2

Checklist for General requirements

This Checklist will assist you in determining if you have met the mandatory format and information requirements as detailed in Guideline 3.1.1 – General requirements. All applications **must** include this Checklist.

General requirements (3.1.1)		
Check	Page No.	Mandatory requirements
		A Form of application
		<input checked="" type="checkbox"/> <i>Application in English</i>
<input checked="" type="checkbox"/>	5	<input checked="" type="checkbox"/> <i>Executive Summary (separated from main application electronically)</i>
		<input checked="" type="checkbox"/> <i>Relevant sections of Part 3 clearly identified</i>
		<input checked="" type="checkbox"/> <i>Pages sequentially numbered</i>
		<input checked="" type="checkbox"/> <i>Electronic copy (searchable)</i>
		<input checked="" type="checkbox"/> <i>All references provided</i>
<input checked="" type="checkbox"/>	7	B Applicant details
<input checked="" type="checkbox"/>	8	C Purpose of the application
	8	D Justification for the application
<input checked="" type="checkbox"/>	10	<input checked="" type="checkbox"/> <i>Regulatory impact information</i>
	11	<input checked="" type="checkbox"/> <i>Impact on international trade</i>
		E Information to support the application
<input checked="" type="checkbox"/>	11	<input checked="" type="checkbox"/> <i>Data requirements</i>
		F Assessment procedure
	11	<input checked="" type="checkbox"/> <i>General</i>
<input checked="" type="checkbox"/>		<input type="checkbox"/> <i>Major</i>
		<input type="checkbox"/> <i>Minor</i>
		<input type="checkbox"/> <i>High level health claim variation</i>
		G Confidential commercial information [Not applicable]
<input checked="" type="checkbox"/>	11	<input type="checkbox"/> <i>CCI material separated from other application material</i>
		<input type="checkbox"/> <i>Formal request including reasons</i>
		<input type="checkbox"/> <i>Non-confidential summary provided</i>
		H Other confidential information [Not applicable]
<input checked="" type="checkbox"/>	11	<input type="checkbox"/> <i>Confidential material separated from other application material</i>
		<input type="checkbox"/> <i>Formal request including reasons</i>
		I Exclusive Capturable Commercial Benefit
<input checked="" type="checkbox"/>	12	<input checked="" type="checkbox"/> <i>Justification provided</i>
		J International and other national standards
<input checked="" type="checkbox"/>	12	<input checked="" type="checkbox"/> <i>International standards</i>
	13	<input checked="" type="checkbox"/> <i>Other national standards</i>
<input checked="" type="checkbox"/>	13	K Statutory Declaration
		L Checklist/s provided with application
<input checked="" type="checkbox"/>	14	<input checked="" type="checkbox"/> <i>3.1.1 Checklist</i>
		<input checked="" type="checkbox"/> <i>All page number references from application included</i>
		<input checked="" type="checkbox"/> <i>Any other relevant checklists for Chapters 3.2–3.7</i>

Appendix 3

Checklist for applications for contaminants and natural toxicants

This Checklist is in addition to the Checklist for Guideline 3.1.1 and will assist you in determining if you have met the information requirements as specified in Guidelines 3.4.1–3.4.3.		
Chemical contaminant and natural toxicant maximum levels (3.4.1)		
Check	Page No.	Mandatory requirements
<input checked="" type="checkbox"/>	15	A.1 Nature of contaminant or natural toxicant
<input checked="" type="checkbox"/>	16	A.2 Analytical detection method
<input checked="" type="checkbox"/>	16	B.1 Toxicokinetics & metabolism information
<input checked="" type="checkbox"/>	19	B.2 Toxicity studies
<input checked="" type="checkbox"/>	21	B.3 Human studies relevant to safety
<input checked="" type="checkbox"/>	28	C.1 List of foods where maximum level is proposed
<input checked="" type="checkbox"/>	28	C.2 Survey data on contaminant or toxicant levels in foods
<input checked="" type="checkbox"/>	33	C.3 Information on levels of consumption
<input checked="" type="checkbox"/>	34	C.4 Where consumption has changed, information on likely consumption