Animal Health Board Project No. R-10724

Human Exposure to Fluoroacetate in Tea and Edible Plants – Could It Exceed Acceptable Intake Limits?

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Landcare Research
Manaaki Whenua

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Summary

Project and Client

Landcare Research, Lincoln, was contracted by the Animal Health Board (Project R-10724) to review literature on fluoroacetate concentrations in tea and plants used for food or medicine. The work was completed 30 November 2009.

Objectives

- To review existing data on fluoroacetate levels in tea and compare these with updated acceptable levels for human exposure in New Zealand (Ministry of Health TDIs).

Methods

- Literature on fluoroacetate in tea and more recent data on fluoroacetate found in New Zealand plants that can be used as food or medicine were reviewed.
- Fluoroacetate concentrations reported for tea and edible plants were compared with the tolerable daily intake (TDI) of 0.03 µg/kg bw/day and expressed as how many cups (or servings in the case of plant material) a person would need to consume on a daily basis to reach the TDI.

Results

- Fluoroacetate has been found in most varieties of tea tested to date (31 out of 32 tea samples tested contained fluoroacetate), presumably because it occurs naturally in the plants used to produce tea. Vartiainen and Kauranen used a rigorous continuous liquid-liquid extraction method designed to extract all traces of fluoroacetate from ‘raw’ tea leaf samples and found fluoroacetate at concentrations up to 380 ng/g. At this concentration, the TDI could theoretically be reached by a 70-kg adult drinking less than three cups of tea a day – however, the presence of such fluoroacetate concentrations in cups of tea as they are commonly prepared by consumers is unlikely.
- Eason et al. took a more ‘consumer oriented’ approach to evaluate fluoroacetate concentrations likely to be ingested by tea drinkers. In samples prepared to simulate common preparation of a cup of black tea, i.e. 2 g tea leaves in 200 mL hot water, fluoroacetate concentrations were below the method detection limit (MDL) of 0.1 ng/mL. In more concentrated samples (10 g tea leaves in 100 mL hot water) fluoroacetate was found at concentrations up to 1.2 ng/g, which extrapolates to 2.4 ng fluoroacetate per cup. Therefore if a person was to consume three cups of tea at this concentration on a daily basis he/she could consume up to 7.2 ng of fluoroacetate a day. Based on these concentrations of easily-extractable fluoroacetate, the amount of tea that a person would need to drink to reach the TDI was estimated at 875 cups of tea per day.
- In the same study, Eason et al. also undertook a more rigorous alkali extraction of tea samples, and concentrations up to 11 ng/g were found. Based on this concentration, found in ‘Tiger’ tea, a person would need to consume 105 cups on a daily basis (each cup containing 10 ng/g) to approach the TDI.
- More recently, studies have been conducted with plants of cultural importance in New Zealand, to determine whether fluoroacetate from 1080 baits could be transferred into the leaves of plants that are harvested for human food or medicine. Field studies were carried out in which 1080 baits were placed near individual plants, including pikopiko (*Asplenium bulbiferum*), karamuramu (*Coprosma robusta*), puha (*Soncha* spp.)

and watercress (*Nasturtium officinale*). Fluoroacetate was not detected in the pikopiko, but transient residual fluoroacetate concentrations were found in some individual plants of the other species. A maximum concentration of 5 ng/g was found in karamuramu. Maximum concentrations of 15 ng/g and 63 ng/g were found in puha and watercress respectively. Based on the highest amounts of fluoroacetate reported for these plant species, individual daily consumption of 420, 140, and 33 g of karamuramu, puha, and watercress, respectively, would reach the TDI.

Conclusions

- Regular consumption of tea would not result in ingestion of fluoroacetate concentrations approaching the TDI. Based on current knowledge of the sublethal effects of fluoroacetate exposure in mammals, such consumption is not expected to pose a significant long-term risk to human health.
- An intake of three cups of tea per day is likely to result in fluoroacetate exposure in the range of 0.017 to 0.1 ng/kg bw/day. Whether such exposure presents a risk of long-term or chronic adverse effects on human health remains unknown.
- It is possible, but highly unlikely, that humans could approach TDI levels if they were regular consumers of karamuramu, puha or watercress that contained fluoroacetate as the result of 1080 baits being on the ground or in the water in close proximity (within 1-m) to the growing plants, within 28 days of an aerial 1080 operation.

Recommendations

- Community concerns regarding the sublethal effects of human exposure to fluoroacetate as the result of 1080 baiting can be addressed through wider and ‘popular science’ publication of the potential levels of fluoroacetate exposure in regular tea drinkers. In particular, unsubstantiated claims of long-term, adverse effects of fluoroacetate exposure on human health at concentrations well below the TDI can be challenged with this review data.
- Herbal tea products currently available in New Zealand may be based on plant species that contain naturally occurring fluoroacetate. If such teas contained higher fluoroacetate concentrations than previously reported, this would provide an up-to-date, ‘new research’ context for ongoing discussion of the health risks of human exposure to fluoroacetate.
- ‘No harvest’ periods for plants of cultural food or medicinal purposes following aerial applications of 1080 baits should be considered on a case-by-case regional basis.

1. Introduction

Landcare Research, Lincoln was contracted by the Animal Health Board (Project R-10724) to review literature on fluoroacetate concentrations in tea and plants used for food or medicine. The work was completed 30 November 2009.

2. Background

Fluoroacetate, the toxic principle of 1080, occurs naturally in a range of plant species worldwide. It was first identified in the South African shrub *Dichapetalum cymosum* and since then has been found in several other *Dichapetalum* species throughout the African continent, with the highest concentrations being found in *D. braunii* (8000 ppm) (Murphy et al. 2003). Fluoroacetate is also found in 35 species from three genera of the Leguminosae in Australia, especially *Gastrolobium*, *Oxylobium*, and *Acacia* (O'Hagan & Harper 1999). Also, some plants can biosynthesise fluoroacetate when exposed to fluoride ions. Soya bean (*Glycine max*) and crested wheat grass (*Agropyron cristatus*) contained concentrations of 4 ppm (4000 ng/g) fluoroacetate after being exposed to a 1 mM fluoride solution (O'Hagan & Harper 1999). Hence some plant genera normally produce fluoroacetate, often at relatively high concentrations and presumably as a toxic defence against browsers – and other plants have the ability to biosynthesise fluoroacetate at low concentrations.

Fluoroacetate has also been reported in plant-based consumables such as brewed tea and guar gum (Vartiainen & Gyunther 1984; Eason et al. 1995; Twigg et al. 1996). Eason et al. (1995) tested 10 common varieties of tea available in New Zealand and measured fluoroacetate concentrations of 0.4–2.4 ng/cup. They concluded that such concentrations were toxicologically insignificant from the perspective of acute oral toxicity to humans.

The TDI (tolerable daily intake) is an estimate of the daily exposure in humans that is likely to be without appreciable health risks during a lifetime of continuous exposure. TDIs are calculated on the basis of laboratory toxicity data from animals to which uncertainty factors are applied. The TDI for fluoroacetate was based on NOAEL (no observed adverse effect level) values from sub-chronic studies conducted with rats (Foronda et al. 2007a, b) and a value of 0.03 µg/kg bw/day is proposed for human health risk assessment of 1080.

Despite this clearly defined 'acceptable' regulatory limit for human exposure to fluoroacetate, concerns continue to be expressed regarding adverse effects on human health resulting from aerial 1080 applications. Current estimates and monitoring data suggest a relatively low risk of public exposure to fluoroacetate in environmental media (water, soil, animals, and plants) as the result of aerial 1080 baiting. However, concerns have focused increasingly on the potential for sublethal, long-term, or chronic toxicity, e.g. endocrine disruption, resulting from environmental exposure to fluoroacetate at concentrations below currently detectable limits (e.g. Weaver 2006, 2007). Some of those opposed to the use of 1080 claim or imply that it has caused human illness such as chronic fatigue or heart problems, without specifying how and to what degree the affected people might have been exposed. While there is no toxicological data regarding the long-term effects on humans of repeated exposure to very low concentrations of fluoroacetate, this seems a very likely exposure scenario for people who drink tea regularly. We sought to contrast the current TDI with existing data about fluoroacetate concentrations potentially present in consumables, and also to outline possible exposure profiles for regular consumers.

3. Objectives

- To review existing data on fluoroacetate concentrations in tea and edible plants and compare these with updated acceptable levels for human exposure in New Zealand (Ministry of Health TDIs).

4. Methods

We reviewed the existing data on naturally occurring fluoroacetate in tea (Vartiainen & Kauranen 1984; Eason et al. 1995; Vartiainen et al. 1995), and also more recent data on fluoroacetate taken up from 1080 baits, in New Zealand plants that can be used as food or medicine (studies by Ogilvie et al. 2006; Miller et al. 2009).

Concentrations reported in these studies were compared with current Ministry of Health regulatory values, such as the tolerable daily intake of 0.03 µg/kg bw/day, and expressed as how many cups (or servings in the case of plant material) a person would need to consume on a daily basis to reach the TDI. This calculation assumes an adult weight of 70 kg, therefore for an adult to reach the TDI that person would need to consume 2.1 µg fluoroacetate per day.

5. Results

5.1 Fluoroacetate in tea

Research into fluoroacetate levels in tea has been conducted by two research groups, one in Finland at the University of Kuopio, and the other by Landcare Research in New Zealand.

Work of Finnish researchers

Vartiainen and Kauranen (1984) measured fluoroacetate in a variety of tea samples (21 types of tea) using a rigorous extraction method designed to extract 100% of the fluoroacetate. However, this paper contained only a summary of the results and the full results were published by Vartiainen et al. in 1995.

Sample extraction was conducted using 0.5-g samples of tea leaves in 100 mL of water containing ammonia in a hot water bath. The particulates were removed by centrifugation and the extracts were acidified with sulphuric acid to reduce the pH to 1.5. The fluoroacetate was extracted into ether for 72 h using a continuous liquid-liquid extraction, then back-extracted by sodium hydrogen carbonate solution. The water phase was then washed with ether and acidified with sulphuric acid to pH 4.0 and finally to pH 1.9 before extraction with ether for another 72 h. Tetrahexylammonium hydroxide solution (THAH) was added to the receiving flask before extraction.

A further 2 mL of THAH was added to the ether flask and the ether was distilled off. The remaining tetrabutyl ammonium fluoroacetate ion pair was extracted three times with dichloromethane then evaporated to dryness under nitrogen and the sample was taken up in pentafluorobenzyl bromide (PFBB). The fluoroacetate derivative was then measured by GC-MS (gas chromatography – mass spectrometry). Vartiainen and Kauranen (1984) provide further details on the extraction and derivatisation methods.

Table 1 Fluoroacetate concentrations in different tea samples detected following rigorous extraction methods (Vartiainen et al. 1995)

Origin of tea	Fluoroacetate (ng/g)
Ceylon	50–160
Grusian	90–330
Krasnodorian	30–90
Lipton’s	10–30
Nestle	60
Twining’s	70–380
Grusian Tea	250
China black tea	110–330
China green tea	230
Ceylon tea	60
Russian tea	250
Herb tea	<10

Work conducted in New Zealand

Eason et al. (1995) evaluated fluoroacetate in a number of different types of tea available in New Zealand and found fluoroacetate (presumably naturally occurring) in low, but detectable concentrations (Tables 2 and 3).

The method used for measuring fluoroacetate was based on the work of Ozawa & Tsukioka (1987, 1989). Aqueous extracts are typically obtained from plant samples by dispersing in an alcohol/water mixture, centrifuging, filtering, and passing through an ion exchange column to extract the fluoroacetate. The fluoroacetate in the aqueous extract or water sample was acidified with hydrochloric acid and converted to the dichloroaniline derivative with N,N'-dicyclohexylcarbodiimide (DCC) and 2,4-dichloroaniline (DCA) using ethyl acetate as the extraction solvent. The derivative was cleaned on a silica solid-phase extraction cartridge to remove excess derivatising agent, eluted with toluene, and quantified by gas chromatography on a BP-5 capillary column with electron capture detection.

In this research, tea samples were treated in the same manner as water/liquid samples (rather than as a sample of plant tissue), to determine whether fluoroacetate could be present in a normally prepared cup of tea. Samples prepared using 2 g of tea in 200 mL of hot water (0.01 g tea/mL of water) did not yield any detectable fluoroacetate, with all samples tested being below the MDL of 0.1 ng/mL. A further experiment was conducted simulating 'stronger' cups of tea, prepared by placing 10 g of tea leaves in 100 mL of hot water (0.1 g of tea/mL of water) for approximately 15 min. This yielded concentrations of 0.2–1.2 ng fluoroacetate per gram of tea leaves. Based on these fluoroacetate concentrations, a cup of tea made using 2 g tea in 200 mL water was estimated to contain 0.4–2.4 ng fluoroacetate per cup (Table 2).

Table 2 Concentration of fluoroacetate extracted from tea leaves by boiling water and extrapolation to amount in a cup of tea

Brand	Concentration in tea leaves (ng/g)[1]	Amount in a cup of tea (ng/cup)	Concentration in a cup of tea (ng/mL)
Bell	0.7	1.4	0.007
Tiger	1.2	2.4	0.012
Edglets	0.2	0.4	0.002
PG Tips	0.2	0.4	0.002
Choysa	0.2	0.4	0.002
Amber Tips	1.0	2.0	0.010
Lapsang Souchong	0.3	0.6	0.003
Green Tea	0.4	0.8	0.004
Healtheries	0.4	0.8	0.004
Earl Grey (Liptons)	0.6	1.2	0.006

[1]Tea prepared using 10 g of tea leaves in 100 mL hot water for 15 min.

An additional experiment tested a more rigorous multiple-alkali-extraction method. A 1-g sample of tea was extracted using 1 mL of concentrated ammonia solution in 50 mL of 30% alcohol/water for 30 min. The extraction was repeated three times and the three samples of extract pooled prior to passing the combined sample through an ion exchange column (Table 3). This yielded concentrations of 0–11 ng fluoroacetate per gram of tea leaves, and based on these concentrations, a cup of tea made using 2 g tea in 200 mL of water could contain 0–22 ng fluoroacetate per cup.

Table 3 Concentration of fluoroacetate in tea leaves extracted using an alkali infusion method

Brand of tea	Concentration in tea leaves (ng/g)[1]	Amount in a cup of tea (ng/cup)
Bell	5	10
Tiger	10	20
Edglets	6	12
PG Tips	11	22
Choysa	10	20
Amber Tips	10	20
Lapsang Souchong	6	12
Green Tea	5	10
Healtheries	4	8
Earl Grey (Lyons brand)	<MDL	0

[1]Samples prepared using 1 g of tea leaves extracted with 1 mL of ammonia in 50 mL of 30% alcohol/water for 30 min.

5.2 Fluoroacetate in edible and medicinal plants of cultural importance

Research has been conducted evaluating fluoroacetate uptake by some New Zealand plants that are used either as a food source or for medicinal purposes, including pikopiko (*Asplenium bulbiferum*), karamuramu (*Coprosma robusta*), puha (*Soncha* spp.), and watercress (*Nasturtium officinale*) (Ogilvie et al. 2006; Miller et al. 2009). These studies were conducted to determine whether plants could take up fluoroacetate that has leached from 1080 bait into the soil (or water for watercress) surrounding these plants as could occur in an aerial 1080 operation. Experiments were conducted in the field using 7–8 plants of each species exposed to 1080 bait and 2–3 control plants for each species. For pikopiko, karamuramu, and puha a single 1080 bait was placed at the base of the plant (representing a worse case), while for watercress a single bait was placed into a stand of watercress below the water line at a density of 1 bait/m^2 (note aerial 1080 operations sow at a rate of about 1 bait per 40m^2). Plant samples were collected at intervals after addition of baits and measured for fluoroacetate concentrations. The main focus of these studies was to measure uptake of fluoroacetate from the surrounding medium. The potential occurrence of naturally occurring fluoroacetate in any of these plant species was not specifically addressed and therefore cannot be discounted.

No fluoroacetate was detected in the pikopiko, but a maximum concentration of 5 ng/g was found in the karamuramu after 7 days and 2.5 ng/g after 14 days before it declined to <MDL by 28 days (Ogilvie et al. 2006). Traces of fluoroacetate were found in puha with a maximum of 15 ng/g detected after 3 days and traces found up to 28 days after exposure, but no fluoroacetate was detected in any samples at 38 days. Fluoroacetate was also found in some of the control samples, indicating that it may occur naturally in puha, albeit at low concentrations. The research on watercress has been completed, but not reported on yet. No fluoroacetate was found in any of the control samples, but three positive samples were found in the treated plants, one 30 min after bait was added (17 ng/g), one after 3 days (8 ng/g), and

one after 7 days (63 ng/g). Given that the bait is in the water with the watercress, contamination of the plants by minute bait fragments cannot be discounted.

5.3 Comparison of fluoroacetate levels with TDIs

Tea

Based on the highest concentration of fluoroacetate found by Vartiainen and Kauranen (1984) of 380 ng/g for Twining's and assuming all the fluoroacetate was extracted, a cup of tea prepared from 2 g of tea leaves in 200 mL water could contain 760 ng fluoroacetate per cup. In this instance the TDI could be reached by an adult drinking less than 3 cups of this tea a day (Table 4).

Table 4 Comparison of fluoroacetate concentrations in tea from Vartiainen et al. (1995) with New Zealand Ministry of Health TDIs

Brand of tea	Rigorous alkali extraction (ng/g)	No. of cups to reach TDI
Twinings	380	2.76
Liptons	10–30	35–105
China green tea	230	4.56

Eason et al. (1995) used two different methods for preparing the samples to more closely simulate preparation of a cup of tea for ingestion. Based on fluoroacetate in tea measured following their rigorous extraction method, a person would need to daily consume 105 cups of Tiger tea (containing 10 ng/g) to reach the TDI. Based on 'easily-extracted' fluoroacetate measured in samples, i.e. using the less rigorous first-extraction method, the amount of tea a person would need to consume to reach the TDI is 875 cups of tea per day (Table 5). Both of these estimates obviously represent unrealistic quantities of tea consumption, so on current data, it is very unlikely that regular ingestion of the tea products tested would approach TDI amounts of fluoroacetate.

Table 5 Comparison of fluoroacetate concentrations in tea from Eason et al. (1995) with New Zealand Ministry of Health TDIs

Brand of tea	Easily-extractable fluoroacetate (ng/cup)[1]	Rigorous alkali extraction (ng/cup)[2]	No. of cups to reach TDI in normal cup of tea (rigorous extraction method)
Tiger tea	2.4	20	875 (105)
Amber tips	2.0	20	1050 (105)
PG tips	0.4	22	5250 (95)

[1]Tea prepared using 10 g of tea leaves in 100 mL hot water for 15 min.

[2]Samples prepared using 1 g tea leaves extracted with 1 mL of ammonia in 50 mL of 30% alcohol/water for 30 min.

Plants

Using the highest amount of fluoroacetate reported to be taken up by plants in field studies (5 ng/g in karamuramu, 15 ng/g in puha, and 63 ng/g in watercress), there is potential for regular consumers to approach TDI quantities (Table 6), with the conservative assumptions that (1) all of the plant material harvested and consumed contained these concentrations of fluoroacetate and (2) that the preparation of the plant material for consumption did not involve significant dilution in water.

The LD_{50} of fluoroacetate to humans is 2 mg/kg (2000 ng/g), so for a 70-kg adult this is a dose of 140 mg (140 000 ng) of fluoroacetate. From the maximum amounts of fluoroacetate found in the plant studies, this equates to a person eating 28, 9.3, and 2.2 tonnes of karamuramu, puha, and watercress, respectively per day, to receive a LD_{50} dose (Table 6).

Table 6 Comparison of fluoroacetate concentrations in plants and New Zealand Ministry of Health TDIs

Plants	Maximum fluoroacetate concentration (ng/g)	Amount to achieve TDI (g)	Amount to reach LD_{50} (g)
Pikopiko	0	NA	NA
Karamuramu	5	420	28 000 000
Puha	15	140	9 333 333
Watercress	63	33	2 222 222

6. Discussion

The presence of fluoroacetate in tea is indisputable, but the potential human health risks from drinking tea are less certain. When tea is prepared in a way to simulate domestic usage, the amount of fluoroacetate appears to be very small (0.4–2.4 ng/cup). To put things into perspective, if a person was to drink three cups of tea containing 2.4 ng fluoroacetate a cup this is equivalent to a person consuming 0.0000048 g (4.8 ng) of 1080 possum bait containing 0.15% fluoroacetate.

Based on the TDI of 0.03µg/kg bw/day, drinking tea poses an acceptably low risk to human health. Even when samples underwent a more rigorous alkali extraction, a tea drinker would still need to consume around 100 cups a day to approach the TDI and be at increased risk of adverse effects on health. What constitutes average tea consumption in New Zealand on a daily basis is unknown and is likely to be variable, but we expect that intakes over 10 cups per day would be considered higher than average.

Vartiainen and Kauranen (1984) found considerably higher levels of fluoroacetate in the tea samples they extracted, but they applied a very rigorous extraction method (consisting of two 72 h liquid-liquid extractions) to their samples which would likely have removed all traces of fluoroacetate from the samples. This indicates that while the tea plant *Camellia sinensis* is capable of producing measurable quantities of fluoroacetate, this is probably of low bioavailability. Further characterisation of the bioavailability of fluoroacetate in tea would provide more accurate estimates of the likely degree of exposure to fluoroacetate in regular tea drinkers.

Naturally occurring fluoroacetate has not been actively found in New Zealand plants, but Twigg et al. (1996) suggested that the ability of plants to produce fluoroacetate is widespread. Therefore the occurrence of fluoroacetate in New Zealand vegetation is possible, although the amounts produced will probably be very low and therefore biologically insignificant. The apparent finding of small amounts (maximum of 11 ng/g) of fluoroacetate in control puha plants is a case in point and should be investigated further. However, the presence of fluoroacetate in 1080-treated plants was transient and it had disappeared by day 38, suggesting either metabolism or excretion by the plants.

Due to the quantity of plant material that constitutes a serving, i.e. an estimate of 100–200g compared with 2 g for a cup of tea, these data suggest plants may pose a higher risk of fluoroacetate exposure than drinking tea. However, karamuramu is not consumed directly as food, but rather it is used for medicinal purposes where it is usually boiled in water and consumed like tea (Ogilvie et al. 2006). In this case boiling the leaves may not remove all the fluoroacetate from the plant material into the tea and in order to reach the TDI someone would need to boil up 400 g of leaves (and extract all the fluoroacetate) into a tea on a daily basis.

Puha and watercress can be eaten on a regular basis, e.g. Tiroi, which is a traditional Maori food typically made from mussels and puha, can be eaten 2–3 times a week by some families (Whyte et al. 2001). Consumption of serving sizes in the range of the quantities outlined in Table 6 (140 g for puha and 33 g for watercress) are within the realms of normality, but it would be unlikely that they would be eaten every day long-term. It should also be noted that the concentrations found in these plant samples were very transient, with no fluoroacetate detected in any samples collected more than 28 days after the operation. Furthermore fluoroacetate was only detected sporadically in samples (3 samples out of 56 watercress plants exposed to 1080 baits, and 14 out of 60 puha plants (including controls) despite the close proximity of 1080 baits to the plants. Baits were deliberately placed very close to plants to simulate the worse case scenario, but in an aerial operation the coverage is estimated to be 1 bait per 40 m^2. Therefore it is very unlikely that consumption of these culturally important plants after a 1080 aerial operation would pose a significant risk of fluoroacetate poisoning to humans.

There is a possibility that other ‘herbal’ tea formulations that comprise different plant species may contain higher concentrations of fluoroacetate than regular tea products based on *Camellia sinensis*. This could especially be the case in teas containing plants closely related to genera already known to produce fluoroacetate. Whether consumers of such teas could potentially approach TDI quantities could be explored by analysis of a selected range of such teas.

7. Conclusions

Regular consumption of tea would not result in ingestion of fluoroacetate quantities approaching the TDI. Based on current knowledge of the sublethal effects of fluoroacetate exposure in mammals, such consumption is not expected to pose a significant long-term risk to human health.

An intake of three cups of tea per day is likely to result in fluoroacetate exposure in the range of 0.017 to 0.10 ng/kg bw/day. Whether such exposure presents a risk of long-term or chronic adverse effects on human health remains unknown.

It is possible, but highly unlikely, that humans could approach TDI levels if they were regular consumers of karamuramu, puha or watercress that contained fluoroacetate as the result of a high exposure to 1080 baits being on the ground or in the water in direct contact with the growing plants, within 28 days of the baits being aerially sown.

8. Recommendations

- Community concerns regarding the sublethal effects of human exposure to fluoroacetate as the result of 1080 baiting can be addressed through wider and ‘popular science’ publication of the potential levels of fluoroacetate exposure in regular tea drinkers. In particular, unsubstantiated claims of long-term, adverse effects of fluoroacetate exposure on human health at concentrations well below the TDI can be challenged with this review data.
- Herbal tea products currently available in New Zealand may be based on plant species that contain naturally occurring fluoroacetate. If such teas contained higher fluoroacetate concentrations than previously reported, this would provide an up-to-date, ‘new research’ context for ongoing discussion of the health risks of human exposure to fluoroacetate.
- ‘No harvest’ periods for plants of cultural food or medicinal purposes following aerial applications of 1080 baits should be considered on a case-by-case regional basis.

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