Quantifying the nitrate levels in bottled water in New Zealand

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Abstract

Objective: There is growing epidemiological evidence linking nitrate contamination to adverse health outcomes. Health concerns may drive consumers towards bottled water, however, nitrate levels in bottled water are not readily available.

Methods: We tested water samples from the 10 most popular brands using a TriOS OPUS UV optical nitrate sensor.

Results: Overall, all bottled water brands tested returned nitrate levels below 4.4 mg/L NO3.

Conclusions: The growing health concerns associated with nitrate contamination suggest that increased reporting of water quality is required.

Implications for public health: Mandatory reporting of water quality laboratory reports by bottled water producers would improve transparency to consumers and help public health researchers track potential threats to water quality as new evidence emerges.

Key words: nitrate, drinking water, cancer, bottled water

Many consumers choose to purchase bottled water because they believe it contains fewer microbiological and toxicological contaminants and so is a healthier choice than tap water.[1] Nitrate is one contaminant in drinking water that emerging epidemiological evidence has linked to adverse birth outcomes and several cancers.[2]

Bottled water companies must comply with national drinking water guidelines. Most countries, including New Zealand and Australia, adopt the World Health Organization (WHO) guidelines for nitrate (NO_3) of 50 mg/L into national drinking water guidelines [all measurements in this article have been converted to and presented as NO_3].[3] The WHO guideline was established to protect against death from infantile Methaemoglobinemia.[3] The current limit does not account for the emerging epidemiological evidence that has shown an increased risk of colorectal cancer and preterm births at levels as low as 3.9 mg/L.[4,5] In New Zealand, a recent study estimated 800,000 people (17% of the population) may be on public and private water supplies with nitrate levels above 3.9 mg/L.[6]

Research investigating nitrate contamination in bottled water is limited. Five previous studies in Argentina,[7] Spain,[8] Italy,[9] Canada[1] and Germany[10] found median nitrate levels in bottled water around or below 4.4 mg/L. However, the maximum nitrate levels observed included 15.5 mg/L, 18.2 mg/L, 31.0 mg/L and 54.0 mg/L. These maximum observed values are far above the levels associated with adverse health outcomes observed in recent epidemiological studies (as low as 3.9 mg/L).[2,4] Nitrate is not required to be reported on product labelling nor is it required to be publicly available (e.g. on a producer's website).

In this research, we aimed to: i) quantify the extent of nitrate contamination in the top water brands in New Zealand; and ii) highlight areas for bottled water companies to improve reporting of water quality to consumers.

Methods

Bottled water brand selection

In New Zealand, 75% of all bottled water is sold through supermarkets. We searched the websites of one supermarket chain from each of the two dominant supermarket companies for all bottled water brands stocked. We excluded any flavoured or sparkling water, as our nitrate sensor was not designed to measure nitrate in carbonated water. Our final sample included 10 bottled water brands from eight different companies (seven sourcing water in New Zealand and one in Fiji). All brands sourced their water from confined groundwater supplies.

Nitrate measurement

Water samples were tested using a TriOS OPUS UV optical nitrate sensor (TriOS, Germany), operated through a proprietary TriBOX3 control unit, the technical specifications of which can be found on the company website (www.trios.de). The OPUS analyses ultraviolet spectra within the 200-360-nm wavelength with a 10-mm pathlength. TriOS report the instrument detection limits for nitrate as 0.1 mg/L and precision checks against nitrate standards were made before deployment using known concentrations. We tested three 5-mL aliquots of each water brand from the same batch and took the median value as per one previous study.[1] We also requested

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the laboratory reports from each bottled water manufacturer and searched the company websites for any publicly available information.

Results

Overall, all bottled water brands tested returned nitrate levels below 4.4 mg/L, with four brands returning non-detectable levels (Figure 1). In total, information from bottled water producers on nitrate levels was retrieved from five of the 10 brands (three via personal correspondence and two via company websites). Two of the brands did not reply to our enquiry, while three refused to provide the information, citing the information was commercially sensitive. The two brands with publicly available information on their website included data on a wide range of contaminants and published their official laboratory reports.

Discussion

The finding of low levels of nitrate in bottled water in this study is consistent with previous studies conducted in multiple jurisdictions.[1,8-10] However, the extreme levels observed in these previous studies were not observed in this current study. Agricultural intensification in New Zealand is a relatively recent phenomenon, meaning the environmental impact may not have substantially affected commercial water sources yet. However, environmental monitoring predominantly conducted in 2020 estimated between 95% and 99% of New Zealand's waterways in urban and agricultural pasture land are polluted.[11] For nitrate in groundwater, 62% of nationally monitored sites are worse than in 2010.[12] Further, the areas where groundwater quality is rapidly degrading are the same areas where the majority of bottled water is extracted.[13] The trends in water degradation suggest that the commercial bottled water industry could be vulnerable to the environmental impacts of New Zealand's rapid agricultural intensification.

The current study only considered a relatively small number of bottled water brands. However, in New Zealand, these brands have ~70% market share of the entire bottled water market, including sparkling water. The exclusion of sparkling water was another limitation, but it has a substantially lower market share of the total bottled water market (~15%). Another limitation was our sample was cross-sectional and it is possible nitrate levels vary between batches. However, the low nitrate levels observed across all brands would suggest between-batch variation is unlikely to have affected the results of this analysis.

The brands reporting their nitrate levels publicly demonstrate an industry best practice that could be incorporated into an upgrade of the *Food Act 2014* to require all New Zealand bottled water brands [including sparkling water] to publish their laboratory reports on chemical contaminants. Further, the Government should consider implementing on-product nitrate reporting, like many European water brands. Collectively, these practices would improve communication to consumers about water quality and enable ongoing monitoring of the quality of bottled water.

There are many environmental health implications inherent in the production and use of bottled water that are beyond the scope of this short report. These concerns include the high energy and resource use of this form of water distribution, the plastic waste implications and the equity implications for communities with inadequate access to safe reticulated water supplies.[14]

Conclusions

Our results show that bottled water in New Zealand typically has low levels of nitrate contamination. However, the growing health concerns associated with nitrate contamination below the WHO standards suggest that increased reporting of water quality is required.

Implications for public health

Mandatory reporting of water quality laboratory reports would improve transparency to consumers and help public health researchers track potential threats to water quality as new evidence emerges.

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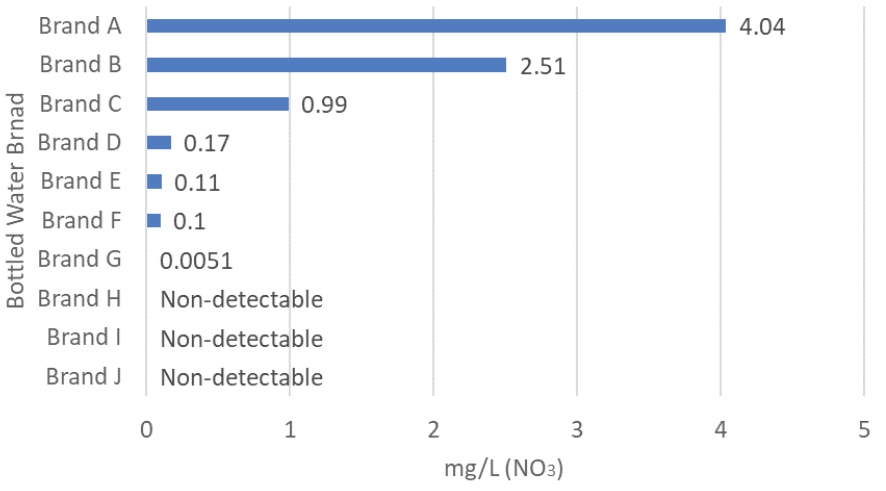
Figure 1: The extent of nitrate contamination in New Zealand's top 10 bottled water brands (in NO_3).



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