Original Article

Comparison of the dietary cobalt intake in three different Australian diets

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Differences in the dietary intake of cobalt were assessed for vegans, lacto-ovo-vegetarian and non-vegetarian Australians using food intake logs, and daily or average trend recall over three months. A significant decrease in cobalt intake was observed for the lacto-ovo-vegetarian population compared with the intake in vegans and omnivores. There is no RDI for cobalt, however, the cobalt intake of Australians was similar to that reported in other countries. Microflora above the terminal ileum have been shown to produce significant amounts of biologically available vitamin B12. This study was unable to demonstrate a correlation between elemental cobalt intake and serum vitamin B12 concentrations in humans, as has been shown *in vitro*.

Key Words: cobalt, lacto-ovo-vegetarian, vegan, Australia

Introduction

Little is known about the role of dietary cobalt, other than as a component of cyanocobalamin, vitamin B12.[1-3] Low levels of cobalt in ruminant diets has been reported to lead to vitamin B12 deficiency,[4] however as humans obtain their vitamin B12 primarily from animal food sources the role of cobalt for this purpose seems limited. Previous studies however, have suggested a role of microbial fermentation in diet supplementation of vitamin B12, in particular by bacteria in the oral cavity and small intestine.[5,6] Vitamin B12 produced by colon bacteria is not absorbed.[7]

The risk of vitamin B12 deficiency in certain dietary groups, such as vegetarians, is well-recognised.[8] Interestingly, it has been reported that the incidence of vitamin B12 deficiency is lower in some countries, than in Australia.[9-10] As it is recognised that the cobalt levels in foods may be influenced by geographical distribution, and by seasonal variation, it is possible that the vitamin B12 levels in some vegetarian communities may be significantly supplemented by indigenous microflora, and this supplementation may be cobalt dependent. This hypothesis has been confirmed *in vitro*.[10] There are no reports of cobalt levels in Australian foods, so to determine the dietary intake, one hundred and fifty foods were analysed by a Finnigan High Resolution Inductively Coupled Plasma Mass Spectrometer,[11] and this data was used to compare the dietary cobalt intake by Australian vegan, lacto-ovo-vegetarian and non-vegetarian populations.

Normal daily intake is reported to be in the range 2.5-3.0mg/day.[12,13] Toxicity with cobalt has been reported to occur within the range of greater than 25-30mg cobalt daily.[1]

Subjects and methods

Foods were analysed for cobalt[11] and daily intake was calculated from food recall records. Diet history records using food intake logs for 24 hours, daily recall or average trend recall over three months, were obtained from informed volunteers. All procedures were performed in accordance to Human Ethics guidelines, with approval given through the University of Newcastle Human Research Ethics Committee.

Diet history data was obtained from three populations: vegans (N=10), lacto-ovo-vegetarians (N=10) and non-vegetarians (N=10). All participants were over the age of eighteen, but results were not stratified for age and gender. Results were calculated using an Excel database and spreadsheet, and are shown in Table 1.

Fasting blood samples were collected from participants, using accepted techniques. Serum vitamin B12 was estimated using the BioRad radio immunoassay method.[14] Estimated elemental cobalt intake was compared with the measured serum vitamin B12 concentration in vegans and lacto-ovo-vegetarians, by linear regression and ANOVA techniques, using the Excel Statistical package.

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Table 1. Calculated daily intake of cobalt by selected groups of Australians

	Mean daily intake µg/day	Standard deviation	Range µg/day
Vegan	40.1 [a]	19.8	17.81 to 81.8
Vegan excluding two participants consuming large amounts of potato	20.8[b]	15.4	17.81 to 36.1
Lacto-ovo-vegetarian	22.7[b]	12.2	6.67 to 37.3
Non-vegetarian	39.7 [a]	16.5	19.6 to 68.5

Values are means (N=10)
Values within a given column with the same superscripts are not significantly different (P>0.05, Student's t-test, two tailed)

Table 2. Measured serum vitamin B12 concentrations of selected groups of Australians.

	Mean serum concentration pmol/L	Standard error of the mean	Range pmol/L
Vegan	175[a]	6.6	86-296
Lacto-ovo-vegetarian	175[a]	6.2	91-325
Non-vegetarian	366	27	166-680

Values are means (N=10). Values within a given column with the same superscripts are not significantly different (P > 0.05, Student's t-test, two tailed)

Results

The average cobalt intakes for the selected population groups are shown in Table 1. A significant difference in cobalt intake was observed between the lacto-ovo-vegetarian group and the other two populations (P<0.05), with no difference between the vegan and non vegetarian groups (P>0.05).

The estimated dietary intake of cobalt by each group was compared with serum vitamin B12 concentration (Table 2) by linear regression and ANOVA. There was no correlation by linear regression (R^2=0.02), and no statistical significance by ANOVA (P=0.34).

Table 3. Daily cobalt intake for various nationalities

Country	Mean daily cobalt intake µg /day
Australia	34.2 (6.6 – 81.8)
France[15]	29
Canada[16]	11
United Kingdom[17]	11-28
Unites States[18]	3.4-11.6
Brazil[19]	13.3-44.6
Spain[20,21]	25

Discussion

The average daily intake of cobalt by Australians was found to be comparable with that reported for other nationalities (Table 3).

The wide range in results from different studies and countries, partially reflects the different methods and technology available, with the more recently reported data [15,19] using the same methods as were used in this study. A major source of cobalt in the Australian diet is from meat and potatoes, and this is reflected in the dietary intake results. The cobalt intake of both vegans and non vegetarians was higher than that of lacto-ovo-vegetarians (P<0.05).

Vegans generally reported consuming more potatoes than the other two groups, accounting for most of the difference. Potatoes contain a high concentration of cobalt (137 µg/kg). The exclusion of two participants that were outliers for potato consumption, reduced the mean cobalt intake of the vegan group to be comparable to that of the lacto-ovo-vegetarian group. The major sources of cobalt in the non vegetarian group were red meat (86µg/kg) and potato (mostly in the form of chips). No clinical significance has been able to be inferred from these differences in intake of cobalt.

The lack of correlation between serum vitamin B12 concentrations and estimated cobalt intake was not surprising. Only a very small amount of elemental cobalt is incorporated into vitamin B12 (0.04µg per 1µg of vitamin B12). Thus assuming all the dietary cobalt consumed by the participant with the lowest intake (6.67 µg) was absorbed, 165µg of vitamin B12 could be manufactured which is far in excess of the RDI of the vitamin. Further studies examining the dietary intake of cobalt of vegetarians with low serum vitamin B12 may provide a better insight into its role in vitamin B12 levels in non-ruminant animals.

The vitamin B12 concentration of vegans is usually significantly lower than that of lacto-ovo-vegetarians.[10] The gap is closing however, as lacto-ovo-vegetarians are consuming fewer eggs and less dairy foods, while the vegans and consuming more foods fortified with vitamin B12.[10] In this study, the vegans were not taking vitamin B12 tablet supplements or IM injections, but the majority were consuming foods supplemented with vitamin B12 eg. *So Good* soy milk alternative. This may account for the unexpected similarity in the mean serum vitamin B12 concentration in both the vegan and lacto-ovo-vegetarian groups.

Conclusion

Although certain vegetarian diets demonstrated a significantly lower cobalt intake than that of the non-vegetarian diet, no correlation could be observed between cobalt intake and serum vitamin B12 levels. This probably reflects the fact that all diets in this study provided cobalt at a level that was within the required range. Overall, the Australian dietary intake of cobalt is reflective of that observed in other countries.

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