Vitamin D

in Australian foods

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What is vitamin D?

The fat soluble vitamin, vitamin D (cholecalciferol (D3) and ergocalciferol (D2), appearing in the circulation as 25-hydroxycholecalciferol (25-OHD3) and 25-hydroxyergocalciferol (25-OHD2)) is known to be present in a range of animal based foods available in Australia. However the amount of data available to date on levels in foods has been limited.

Vitamin D status of Australians

The 2011-13 Australian Health Survey studied the vitamin D status of Australians and estimated that 23.5% of Australians over the age of 18 years had serum levels of vitamin D that indicated deficiency[(1)].

When updated nutrient reference values for vitamin D were released in 2006[(2)], it was noted that accurate estimates of vitamin D intake were not available due to there being limited compositional data in national food composition databases.

Methods of vitamin D analysis

In part, the lack of data on vitamin D levels in Australian foods has reflected difficulty in analysing the low levels of vitamin D present in unfortified foods. Data from Denmark reported that trimmed beef and lamb contained an average of 0.4 µg /100 g [(3)]. In past analyses of Australian meats using HPLC with photo diode array or UV detection, the limit of reporting (LOR) for the available method was as high as 5 µg/100 g for D3 and 25-OHD3[(4)]. At this limit, the method was only appropriate for use in fortified foods such as margarine spreads (6.5 µg D3/100 g[(5)]). In recent years, improved methods of analysis (such as LC-IT-MS) have seen this limit reduced to as low as 0.03 µg/100 g for D3 and 0.05 µg/100 g for 25-OHD3[(6)] in some meats, and work continues to further refine the methods of analysis and associated LORs.

Sampling and analysis

Given the interest in the vitamin D content of foods and the availability of the improved methods of analysis, Food Standards Australia New Zealand (FSANZ) commissioned a study to develop a preliminary dataset for D3, D2, 25-OHD3 and 25-OHD2 in a range of popular animal-based foods sold in Australia.

Twenty-two foods were selected in five Australian cities (Canberra, Perth, Adelaide, Brisbane and Melbourne) in May 2015 (20 foods) and August 2015 (2 foods). Beef, lamb, pork and chicken samples were separated into lean meat and fat/skin portions. Foods that are typically consumed in the cooked state, but purchased in the raw state, were cooked in the laboratory using typical home cooking techniques, without the addition of water or fat.

Samples were analysed by normal phase LC-IT-MS[(6)] at the National Measurement Institute (Melbourne, Australia), an ISO 9001 certified laboratory. The LOR achieved for all analytes was 0.2 µg/100 g, except in milk where a lower limit (0.1 µg/100 g) was able to be achieved.

Results

No D2 or 25-OHD2 were detected in any of the samples. Results for D3 and 25-OHD3 are available in Table 1. A full report of this project is available on the FSANZ website[(7)].

Table 1. D3 and 25-OHD3 content of foods (as purchased and/or cooked, per 100 g edible portion).

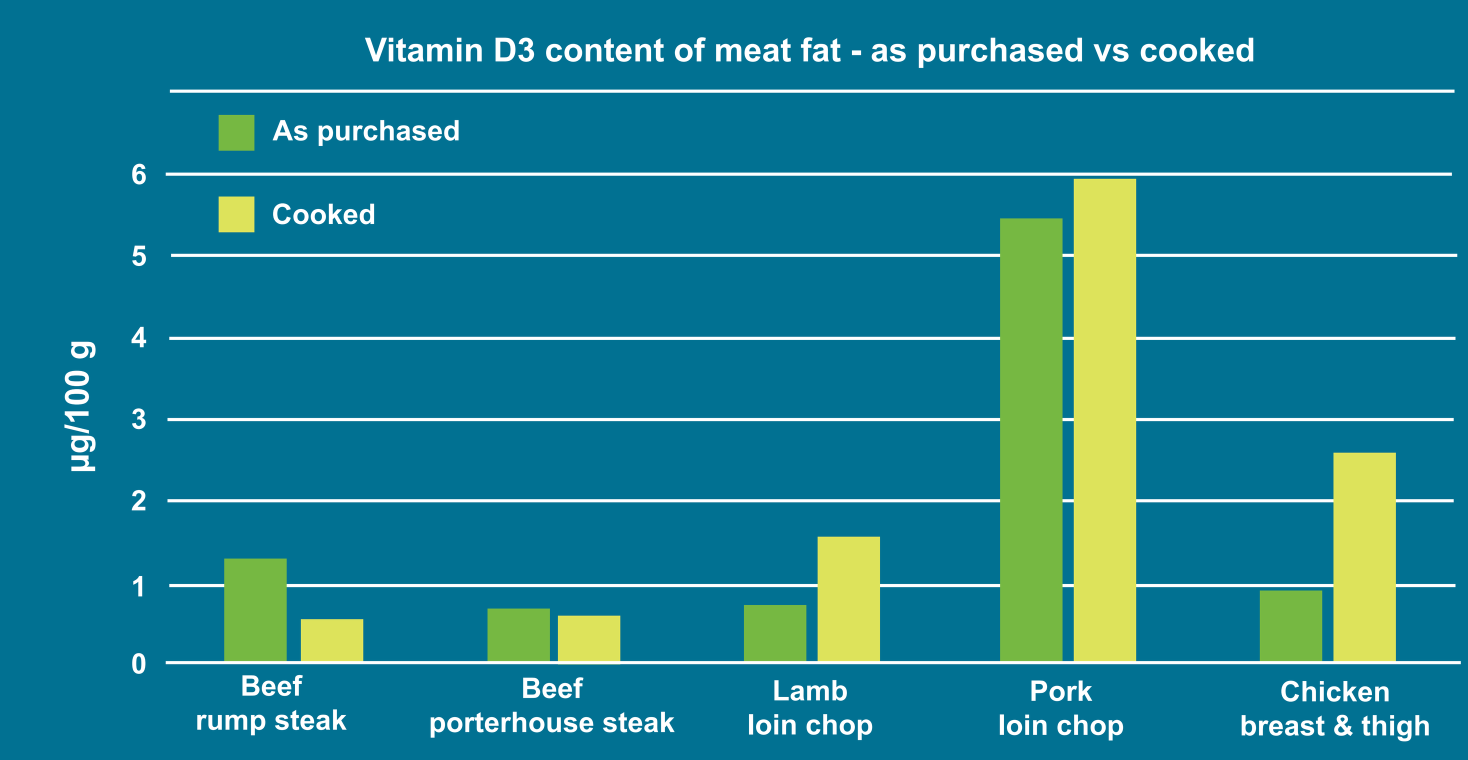
Food	D3 µg/100g		25-OHD3 µg/100 g	
Lean meat:	**As purchased**	**Cooked**	**As purchased**	**Cooked**
Beef, mince, regular fat	0.2	0.4	0.6	0.5
Beef, rump steak	<0.2	<0.2	0.7	0.3
Beef, blade steak	0.3	0.7	0.2	<0.2
Pork, loin chop	0.4	0.4	<0.2	<0.2
Lamb, loin chop	<0.2	<0.2	0.6	0.3
Chicken, breast, skinless	<0.2	<0.2	<0.2	<0.2
Chicken, leg and thigh, skinless	0.3	<0.2	1.3	2.3
Fat only:	**As purchased**	**Cooked**	**As purchased**	**Cooked**
Beef, rump steak	1.3	0.5	<0.2	<0.2
Lamb, loin chop	0.7	1.6	<0.2	<0.2
Beef, porterhouse steak	0.7	0.6	<0.2	<0.2
Pork, loin chop	5.5	6.0	<0.2	<0.2
Chicken, fat and skin only	0.9	2.6	1.0	1.0
Fish and fish products:	**As purchased**	**Cooked**	**As purchased**	**Cooked**
Salmon, skinless	3.3	3.3	0.7	1.1
Snapper, skinless	2.9	2.5	0.5	0.6
Hoki, skinless	0.8	0.6	<0.2	<0.2
Hoki, crumbed or battered, baked	-	0.2	-	<0.2
Shark, skinless, battered, deep fried	-	0.3	-	<0.2
Tuna, canned, drained	3.3	-	<0.2	-
Dairy products & eggs:	**As purchased**	**Cooked**	**As purchased**	**Cooked**
Egg, chicken, whole, raw	1.7	-	1.1	-
Milk, cow, regular fat	<0.1	-	<0.1	-
Milk, cow, reduced fat	0.1	-	<0.1	-
Cream, regular fat	<0.2	-	<0.2	-
Cheese, cheddar, regular fat	<0.2	-	<0.2	-
Cheese, cheddar, reduced fat	<0.2	-	<0.2	-
Cheese, parmesan	<0.2	-	<0.2	-
Cheese, brie or camembert	<0.2	-	<0.2	-

Discussion

Some unexpected results were seen in the analysis of foods for vitamin D content. Given that vitamin D is fat soluble, it could be assumed that higher fat portions or varieties of a food would have higher vitamin D content. These results showed that the separable fat of meat samples did have higher vitamin D content, but not proportional to their fat content. For milk, the reduced fat sample had a D3 content at the LOR, while D3 in the full fat milk sample could not be quantified. The significance of these findings requires further investigation, particularly in relation to measurement uncertainty.

The effects of cooking on levels of vitamin D were variable. Some samples saw an increase in vitamin D content once cooked (25-OHD3 in salmon, D3 in lamb, pork and chicken fat), others saw a decrease (D3 in beef fat), while others remained similar to their raw state (D3 in pork chop and salmon). Levels of vitamin D after the cooking process may be influenced by a number of factors including dehydration of the food matrix, thermal stability of the vitamin analogue and the degree of oxidation. Some of these factors may result in an apparent increase in vitamin D, while others would result in a reduction. A comparison of cooking effects on separable fat of the meat samples is provided in Figure 1.

Figure 1. D3 content of 'as purchased' and 'cooked' meat fat, per 100 g edible portion.



There were no quantified results for D2 or 25-OHD2 in any samples. This was expected as the only food known to contain D2 is mushrooms. Mushrooms were not included in this work as a study of these had taken place in 2015[(7)]. However, this study revealed a large number of results for D3 and 25-OHD3 which were below the LOR. This indicates that additional development of the analytical methodology may still be required in order to achieve quantifiable results for these foods.

Future work

This study has provided some data that can be used as a foundation for developing a complete vitamin D dataset for the Australian Food Composition Database (formerly NUTTAB). Given the limited number of samples involved, future analysis could expand the range of foods and varieties within those foods. Replicate analyses could also be conducted to provide additional confidence in the results. Future studies should also aim to generate further data on vitamin D retention in foods under a range of cooking conditions.

Limitations of food composition data

In general, there will always be limitations with food composition data. Nutrient data should be regarded as approximations of the likely nutrient content of the food to which they refer. There are inherent factors affecting nutrient composition (e.g. the species of a fish that is selected) and also aspects associated with variability in production, formulation and storage practices[(8)]. This study was also limited in scope due to the high cost of vitamin D analysis.

References

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