VITAMIN D IN FOOD

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Vitamin D deficiency and associated health risks are a problem that needs to be handled around the world. Generally, dietary intake recommendation is not met. The calculation of dietary intake is a combination of content of vitamin D in our food and information on the amount of food consumed.

The analytical data for vitamin D in food samples are no better than the sampling strategy and the performance of the analytical methods. Due to the development of simpler and cheaper chemical analyzes of vitamin D, information on vitamin D content in food have markedly increased the last 5-10 years.

In food vitamin D activity derives from the parent forms vitamin D3 (vitD3) and vitamin D2 (vitD2) and the hydroxylated forms 25-hydroxyvitamin D3 (25OH-D3) and 25-hydroxyvitamin D2 (25OH-D2). VitD3 and 25OH-D3 are found in fish, eggs, meat, and dairy products [1], vitD2 is found in wild mushrooms, whereas beef and dairy products contain vitD2 and 25OH-D2 [2-4].

To calculate total vitamin D activity in food conversion factors between the different vitamin D forms are essential [5]. The contribution to vitamin D activity from 25-hydroxyvitamin D3 compared to vitamin D3 has been assessed to 1.5-5 in human intervention studies [6-8]. Studies that have compared the effect of dietary intake of vitD3 and vitD2 on the vitamin D status have been evaluated in a systematic review and meta-analysis [9]. The overall conclusion was that when vitamin D was administered once or as a monthly bolus, vitD3 was superior to vitD2 in increasing the vitamin D status, whereas no difference in the vitamin D status was observed if vitD2 and vitD3 were administered on a daily basis [9]. The only human intervention study performing a randomized cross-over design in testing the difference in vitamin D status by administration of daily vitD3 and vitD2 found vitD3 to be superior to maintain vitamin D status [8].

The best available vitamin D source are cod liver oil (90-250 µg/100g) and fatty fish e.g. aqua-culture salmon (6-10 µg/100g) and wild mackerel (5-8 µg/100g) [1, 10-12]. But as the dietary intake depends on the amount consumed, food products with lower content also plays a role. Thus, vitamin D3 and 25-hydroxyvitamin D3 are found in fish, eggs, meat, and dairy products, vitamin D2 is found in wild mushrooms or cultivated mushroom exposed to UVB, whereas beef and dairy products contain vitamin D2 and 25-hydroxyvitamin D2. Content of vitamin D in food of animal origin depend on species, but also on the feeding or the indoor facility for our livestock. Vitamin D, given to domestic animals in the feed varies between regions. Research shows that we are able to increase the content of vitamin D in food products by changing the feeding and facilities for our livestock. A terminology for these possible new products is bio-fortified food [2,13-14]. The beneficial effect for this strategy is in EU limited due to the restriction for the maximum content of vitamin D in feed for livestock [15]. However, within this limit it is still possible to increase the content in food of animal origin as the recommendation. E.g. in Denmark, the current recommendation is 400 IU/kg feed to slaughter pigs, if increased to the maximum level in EU at 2000 IU/kg would increase the content of vitamin D by a factor 3 [14]. In eggs, vitD may be increased 10 times compared to current maximum level without providing any harm to the hens, but the one egg may contain vitamin D which is recommended [13].

Intervention studies have shown the possibility of increasing dietary intake with dietary supplements, enriched food and bio-fortified food. Some countries have chosen to introduce mandatory fortification, for example Finland, or some countries have many enriched foods for example US, while others still discuss what strategy to bring into their country.

References

1. DTU Fødevareinstituttet. Welcome to Fooddata. Available online: http://fooddata.dk/ (accessed on 16-08-2018).

2. Teichmann,A.; Dutta, P.C., Staffas, A.; Jagerstad, M.Sterol and vitamin D2 concentrations in cultivated and wild grown mushrooms: Effects of UV irradiation. LWT. 2007, 44, 815–822.

3. Duffy, S.; Rajauriaa, G.; Clarke, L.C.; Hayes, A.; O'Grady, M.N.; Kerry, J.P.; Jakobsen, J.; Cashman, K.D.; Kelly, A.K.; O'Doherty, J. Vitamin D-biofortified beef: a comparison of cholecalciferol with synthetic versus UVB-mushroom derived ergosterol as feed source. Food Chem. 2018, 256, 18–24.

4. Jakobsen, J.; Saxholt, E. Vitamin D metabolites in bovine milk and butter. J Food Comp Anal. 2009, 22, 472-478.

5. Ovesen, L.; Brot, C.; Jakobsen, J. Food contents and biological activity of 25-hydroxyvitamin D: A vitamin D metabolite to be reckoned with? Ann. Nutr. Metab. 2003, 47, 107–113.

6. Cashman, K. D.; Seamans, K. M.; Lucey, A. J.; Stöcklin, E.; Weber, P.; Kiely, M.; Hill, T. R. Relative effectiveness of oral 25-hydroxyvitamin D3 and vitamin D3 in raising wintertime serum 25-hydroxyvitamin D in older adults. Am. J. Clin. Nutr. 2012, 95, 1350–1356, doi:10.3945/ajcn.111.031427.

7. Jetter, A.; Egli, A.; Dawson-Hughes, B.; Staehelin, H. B.; Stoecklin, E.; Goessl, R.; Henschkowski, J.; Bischoff-Ferrari, H. A. Pharmacokinetics of oral vitamin D3 and calcifediol. Bone 2014, 59, 14–19, doi:10.1016/j.bone.2013.10.014.

8. Jakobsen, J.; Andersen, E.W.; Christensen, T.; Andersen, R.; Bügel, S. Vitamin D vitamers affect vitamin D status differently in young healthy males. Nutrients, 2018, 10, 12; doi:10.3390/nu10010012.

9. Tripkovic, L.; Lambert, H.; Hart, K.; Smith, C. P.; Bucca, G.; Penson, S.; Chope, G.; Hyppönen, E.; Berry, J.; Vieth, R.; Lanham-New, S. Comparison of vitamin D2 and vitamin D3 supplementation in raising serum 25-hydroxyvitamin D status: a systematic review and meta-analysis. Am. J. Clin. Nutr. 2012, 95, 1357–1364, doi:10.3945/ajcn.111.031070

10. Mattvaretabellen. Available online: http://matvaretabellen.no/fish-and-shellfish-g4 (accessed on 16-08-2018).

11. USDA Food Composition Databases. Available online: https://ndb.nal.usda.gov/ndb/ (accessed on 16-08-2018).

12. Livsmedelsverket. Food and content. Available online: https://www.livsmedelsverket.se/livsmedel-och-innehall. (accessed on 16-08-2018).

13. Mattila, P.; Lehikoinen, K.; Kiiskinen, T.; Piironen, V. Cholecalciferol and 25-Hydroxycholecalciferol Content of Chicken Egg Yolk As Affected by the Cholecalciferol Content of Feed. J. Agric. Food Chem. 1999, 47, 4089-4092.

14. Burild A, Lauridsen C, Faqir N, Sommer HM, Jakobsen J (2016): Vitamin D3 and 25-hydroxy vitamin D3 in pork and their relationship to the vitamin D status in pigs. J Nutr Sci, 2016, 5, e3, 1-6.

15. List of the authorised additives in feedingstuffs published in application of Article 9t (b) of Council Directive 70/524/EEC concerning additives in feedingstuffs. Available online: https://eur-lex.europa.eu/legal-content (accessed on 02-09-2018).