

## Fortification with vitamin D: Comparative study in the Saudi Arabian and US markets

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ABSTRACT

**Background and Objective:** Vitamin D deficiency is common among Saudi Arabian population. To evaluate the current status of vitamin D fortification and calcium content of commonly consumed food items by the Saudi population and to compare it to US data. **Setting and Design:** Cross-sectional market survey at markets of Eastern Province of Saudi Arabia and State of Illinois, USA. **Methods:** A dietary survey was carried out for the content of calcium and vitamin D on the most commonly consumed food products by the Saudi population which are suppose to be fortified by vitamin D. The survey included different brands of fresh milk, yoghurt, powdered milk, cheese, ready-to-eat breakfast cereals and orange juice. Vitamin D content in the products studied from the Saudi marketplace was compared with the suggested vitamin D content in the same products according to US Code of Federal Regulations recommendations. **Results:** The overall calcium content in the processed dairy products is generally higher than the content in fresh dairy products. Vitamin D content in the fresh dairy products varied from 40 IU/L to 400 IU/L. None of the cereals or orange juice in Saudi Arabia contain vitamin D supplement. The vitamin D content in the food items from the Saudi marketplace is mostly lower than recommended by the US Code of Federal Regulations. **Conclusion:** Most commonly consumed food products by Saudi population which are suppose to be fortified by vitamin D either not fortified or contain an amount less than recommended by guidelines set for US marketplace.

**Key Words:** Food, fortification, Saudi Arabia, United States, vitamin D

### INTRODUCTION

Nutritional deficiencies are common worldwide and continued to be the leading risk factor for health loss.<sup>[1]</sup> Deficient intake of essential vitamins and minerals (micronutrients) that is important for energy metabolism and other functions of the human body remains also to be widespread.<sup>[2]</sup> Vitamin D, which is an essential fat-soluble vitamin known to be important for bone and muscle health and found recently to be linked to several chronic diseases.<sup>[3,4]</sup> In spite of being a sunny country, hypovitaminosis D is documented to be highly prevalent in Saudi Arabia.<sup>[5,6]</sup>

Vitamin D production due to sun exposure is influenced by many factors which can hinder the formation of vitamin D from skin.<sup>[7]</sup> On the other hand the ultraviolet B wavelengths that photo chemically produce vitamin D in the skin are reported to cause skin cancer.<sup>[8]</sup> The importance of dietary source of vitamin D is reflected in the 1997 dietary guidelines for vitamin D intake developed by the Institute of Medicine of the US National Academy of science.<sup>[9]</sup> In fact dietary patterns, alone, can influence serum 25-hydroxy vitamin D (25 OHD) level,<sup>[10]</sup> but unfortunately foods naturally containing vitamin D are limited.<sup>[11]</sup> One of the methods to prevent micronutrient malnutrition is through food fortification.<sup>[12]</sup> Vitamin D fortified foods were shown to improve vitamin D status in adults.<sup>[13]</sup> Because of that, some countries such as Canada, US and European Union have developed regulation for mandatory or optional fortification of designated staple food items by different micronutrients including vitamin D in order to ensure that all people can benefit.<sup>[14,15]</sup> This study was carried out to evaluate the current status of vitamin D fortification and calcium content of commonly consumed food items by the Saudi population and to compare it to the US markets.

Access this article online	
Quick Response Code:	Website: www.jfcmonline.com
	DOI: 10.4103/2230-8229.108186

## MATERIALS AND METHODS

A market survey was carried out by the investigators in the local marketplace of Al Khobar city located at the eastern province of Saudi Arabia. During the survey the most commonly consumed food products by the Saudi population which are supposed to be fortified and serve as the predominant food source of vitamin D had been identified and evaluated for the content and strength of calcium and vitamin D. The nutrient content had been studied through evaluation of the nutrition facts panel attached to each food item. Since no Saudi national guidelines for food fortification, vitamin D content in the products studied from the Saudi marketplace was compared with the similar products used in the American markets. Survey was carried out during the period of February 1, 2010 to February 28, 2010. The study was approved by the research and ethical committee of the University of Dammam and King Fahd Hospital of the University.

Products surveyed included fresh milk, yogurt, powdered milk, cheese, cereals and orange juice. Commonly used brands were selected from each product. Among the fresh milk, butter milk and yoghurt: Al-Marai, Al Safi, Nada, Nadec, Najdah, Rayan and Activa were chosen. The powdered milk brands studied are: Nido, Rainbow, Anchor and Lona. In the cheese group; Kraft, Al-Marai, Nadec, Anchor and Lona were included for analysis. While from ready-to-eat breakfast cereals group, Kelloggs, Nestle County, Cocoa, Cheerios and Oat meal had been evaluated. Regarding the juices, only orange juice from several brands such as Almarai, Danhoe and others was studied.

## RESULTS

All food items screened had a brief nutrition facts panel. Calcium is generally expressed in milligram (mg) while vitamin D is expressed in international unit (IU). As expected the calcium content in the cereals is less than the content in the processed milk products. None of the orange juice brands is fortified with calcium [Table 1]. One brand of fresh milk, butter milk and yogurt is not fortified with vitamin D while the vitamin D content in the other brands studied varied from 40 IU/L to 400 IU/L. All brands of powdered milk product were fortified with vitamin D and the content ranged at 65.6 IU/g -350 IU/g. Comparison between Vitamin D content in the products studied from the Saudi marketplace and the US market which is recommended by the US Code of Federal Regulations showed that vitamin D content in the food item from the Saudi marketplace is mostly lower than recommended dose which is sold in the US markets [Table 2].

## DISCUSSION

Food fortification of essential micronutrients is important to prevent deficiencies which are commonly present in any society. The most successful global fortification experience is the fortification of salt with iodine.<sup>[16]</sup> In general milk, milk products, cereals and margarines are commonly used in the process of fortification with vitamin D. For example in the US, milk and ready-to-eat cereals are the predominant food source of vitamin D<sup>[14]</sup> while in Finland all retail milk, butter milk and margarines are fortified with vitamin D.<sup>[17]</sup> Cheese was also found to be suitable for vitamin D fortification.<sup>[18]</sup> Orange juice has been proved lately to be a potential vehicle for vitamin D fortification and both vitamin D<sub>2</sub> and vitamin D<sub>3</sub> are equally bio-available in orange juice.<sup>[19]</sup> Bread can also be effective in the process of vitamin D fortification.<sup>[20]</sup> Our survey in the Saudi marketplace revealed that at least one brand of liquid milk and soft milk product and most cheese brands are not fortified with vitamin D. Also none of the cereals or orange juice products surveyed contains vitamin D fortification.

The amounts of vitamin D added to food items also vary with different fortification policy. But in general it depends on energy content and the intended use of the product.<sup>[21]</sup> Several models for optimal food fortification have been developed in the last few years.<sup>[22]</sup> A recent meta-analysis demonstrated a significant positive association comparable to an increase of 1-2 nmol/l in serum 25 OHD level for every 100 additional units of vitamins D.<sup>[23]</sup> The only fortification policy in Saudi Arabia is mandatory fortification premix of enriched wheat and enriched treated flour including its fortification with vitamin D at a concentration of  $\geq 551.15$  IU/kg (55.1 IU/100g), calcium at concentration of  $\leq 2115$  mg/kg and folic acid at a concentration of 1.5 mg/kg.<sup>[24]</sup> This is lower than the bread fortification with vitamin D in Finland which is 80 IU/100 gm.<sup>[15]</sup> Fortification is mandatory in Canada for beverage milk (100 IU/250 ml).<sup>[14]</sup> According to the US Code of Federal Regulations, the addition of vitamin D to fluid milk products is optional. If added however, the level of vitamin D should be 400 IU per quart.<sup>[25]</sup> This is also applied to the soft milk products such as yoghurt and in case of dry milk, each quarter of the reconstituted product should contain 400 IU.<sup>[26]</sup> While Finnish Ministry of Social Affairs and Health recommended that fluid milks, butter milk, yoghurt and milk products to be fortified by vitamin at strength of 0.5 ug/100 ml.<sup>[21]</sup> It is also recommended by the US Code of Federal Regulations that the amount of vitamin D in cheese and cheese products should not exceed 270 IU/100 gm.<sup>[26]</sup> Fortification of ready-to-eat breakfast cereals and calcium-fortified fruit juices with vitamin D

**Table 1: Calcium and vitamin D content of different brands studied**

Product	Brand	Calcium	Vitamin D
Fresh milk	Al Marai	100 mg/100 ml	400 IU/L
	Al Safi	110 mg/100 ml	40 IU/L
	Nada	110 mg/100 ml	400 IU/L
	Nadec	119 mg/100 ml	40 IU/L
	Najdah	100/100 ml	None
Powdered milk	Nido	860 mg/100 g	230 IU/100 g
	Rain bow	930 mg/100 g	65.6 IU/100 g
	Anchor	940 mg/100 g	150 IU/100 g
	Lona	960 mg/100 g	350 IU/100 g
Cheese	Kraft (Processed Cheddar)	1000 mg/100 g	None
	Kraft slice cheese (Original)	1143 mg/100 g	None
	Al Marai cheese		None
	Nadec slice cheese	460 mg/100 g	None
	Anchor	940 mg/100 g	150 IU/100 g
	Lona	960 mg/100 g	350 IU/100 g
Butter milk –Yoghurt	Al Marai	100 mg/100 ml	400 IU/L
	Al Safi	110 mg/100 ml	40 IU /100 ml
	Nada	110 mg/100 ml	400 IU/L
	Nadec	119 mg/100 ml	40 IU /100 ml
	Rayan		400 IU/L
	Najdiah	100 mg/100 ml	None
Cereals	Kelloggs	456 mg/100 g	None
	Nestle country corn flakes	450 mg/100 g	None
	Nestle corn flakes	500 mg/100 g	None
	Cocoa		None
	Cherios		None
	Oat meal		None

**Table 2: Vitamin D content of different products from Saudi markets compared to US guidelines**

Product	Saudi market	US market (usual fortification level)*
Fresh milk	0-400 IU/L	400 IU/quarter
Yoghurt	0-400 IU/L	40-80 IU/RACC**
Powdered milk	65.6 -350 IU/100 g	400 IU/quarter (reconstituted)
Orange juice	0	400 IU/quarter
Cereals	0	40-140 IU/serving
Cheese	0-350 IU/100 gm	Up to 270 IU/100 g

\*References [26,27] \*\*RACC, reference amount customarily consumed or the US FDA regulatory serving size

40-140 IU/serving and 400 IU/quarter respectively is also optional in the United States.<sup>[25,26]</sup> Dietary vitamin D intake by the Saudi population has been calculated long time ago at approximately one-tenth of the daily intake of that in the United States.<sup>[27]</sup> In spite of acceptable amount of calcium content in the products surveyed, the low concentration or absence of vitamin D in these food items can hinder the absorption of the calcium.<sup>[28]</sup>

In one study, 26 of the 42 milk samples (62%) contained less than 80% of the amount of vitamin D claimed on

the label, no vitamin D detected in 3 of the 14 samples of skim milk tested and one milk sample labeled as containing vitamin D<sub>2</sub> contained vitamin D<sub>3</sub> and there was no improvement in the fortification process when reevaluated after one year.<sup>[29,30]</sup>

The main aim of fortification of the vitamin D is to prevent vitamin D deficiency. Initial assessment of Vitamin D status in Saudi Arabia was published in 1983 by Sedrani and his colleagues found vitamin D deficiency was <30% of the samples surveyed.<sup>[31]</sup> Al-Turki *et al.* (2008)<sup>[32]</sup> and Sadat-Ali *et al.* (2009)<sup>[6]</sup> found the prevalence reaching >50%, whereas Elsammak *et al.* (2011)<sup>[33]</sup> found the deficiency to reach about 98%. Compared to Saudi data the reported prevalence of vitamin D deficiency is 41.6%.<sup>[34]</sup>

This survey has some limitations including being limited survey carried out through personal efforts and the fact that nutrient content has been taken from the nutrient fact panel provided by the producers rather than through actual measurement. However, our survey gains its strength from being the first attempt to study food fortification in Saudi Arabia according to our knowledge.

## CONCLUSION

Most commonly consumed food products by the Saudi population which are suppose to be fortified with vitamin D either not fortified or contain an amount less than recommended by guidelines from the developed countries. In view of high prevalence of vitamin D deficiency among Saudi population and the documented low vitamin D intake, national strategies to improve food fortification is required to prevent high prevalence of hypovitaminosis D.

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**How to cite this article:** Sadat-Ali M, Al Elq A, Al-Farhan M, Sadat NA. Fortification with vitamin D: Comparative study in the Saudi Arabian and US markets. *J Fam Community Med* 2013;20:49-52.  
**Source of Support:** Nil, **Conflict of Interest:** Nil