# Nutrient Composition Comparison of Cow's Milk with Plant Based Milk Alternatives

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## Abstract

**Background:** The U.S. Food and Drug Administration's Total Diet Study (TDS) collected and analyzed samples of cow's milk (whole, reduced fat, skim) and plant-based milk alternatives (PBMAs). Data generated from the program for these foods include various mineral nutrients. The 2020 Dietary Guidelines for Americans (DGA) recommend plain cow's milk or unsweetened fortified soy beverage for children at least 12 months of age to meet calcium and potassium needs. The 2020 DGA also recommend dairy products for pregnant and lactating women to meet necessary iodine requirements.

**Objective:** Nutrient data from cow's milk (whole, reduced fat, and skim) and soy and almond PBMA TDS samples collected from October 2017 through March 2020 (FY 2018 – FY 2020) were compared.

**Description:** Calcium, iodine, iron, and potassium were selected for comparison. Whole, reduced fat, and skim milk (N = 27 each) had average calcium concentrations of 117, 121, and 124 mg/100g, respectively. Both soy and almond beverage (N = 3 each) had higher average calcium concentration with 190 and 193 mg/100g, respectively. This is most likely due to the fortification of soy and almond beverages. Average iodine concentrations in the three cow's milk types were 10 – 11 times higher than soy beverage and 30 – 33 times higher than almond beverage. Soy and almond beverage had 49 – 88 times and 21 – 37 times higher average iron concentrations, respectively, than all types of cow's milk. Average potassium concentrations were similar for whole, reduced fat, and skim milk and soy beverage and about 2 times higher than almond beverage.

**Conclusion:** Cow's milk remains a source of important nutrients like calcium, iodine, and potassium. PBMAs may be a source of iron and if fortified, a source of calcium. As PBMAs become more common, it is important to be aware of nutrient recommendations for those who frequently consume these products to ensure appropriate nutrition.

## Background

The U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (HHS) jointly released the first DGA in 1980. The 1980 DGA did not focus on advice for specific age groups very closely and gave general advice to maintain health and nutrition. Beginning in 1990, specific amounts of dairy products such as milk, yogurt, and cheese were recommended to maintain a healthy weight and proper nutrition. There is no mention of any PBMAs until the 2000 DGA where a soy-based beverage with added calcium is an acceptable non-dairy source of calcium (4).

The TDS has been monitoring the U.S. food supply for various contaminants and nutrients since 1961. Nutrient elements, including calcium, iodine, iron, and potassium were analyzed as part of the TDS beginning in 1973. Beginning in FY 2018, the TDS updated its food list to include PBMAs for the first time.

## Objective

As part of modernizing the TDS, a new food list was created for collection beginning in FY 2018. Data from What We Eat in America (WWEIA), the food consumption portion of the National Health and Nutrition Examination Survey (NHANES) showed that consumption of PBMAs had increased. Figure 1 shows the mean per capita (MPC) intake for cow's milk, soy PBMA and almond PBMA. Based on this information, soy and almond PBMAs were included on the TDS food list for collection for the first time.

TDS data collected from FY 2018 through FY 2020 were used to compare the nutrient composition between three types of cow's milk (N=27 each), soy PBMA (N=3), and almond PBMA (N=3). The nutrients selected for comparison were calcium, iodine, iron, and potassium.

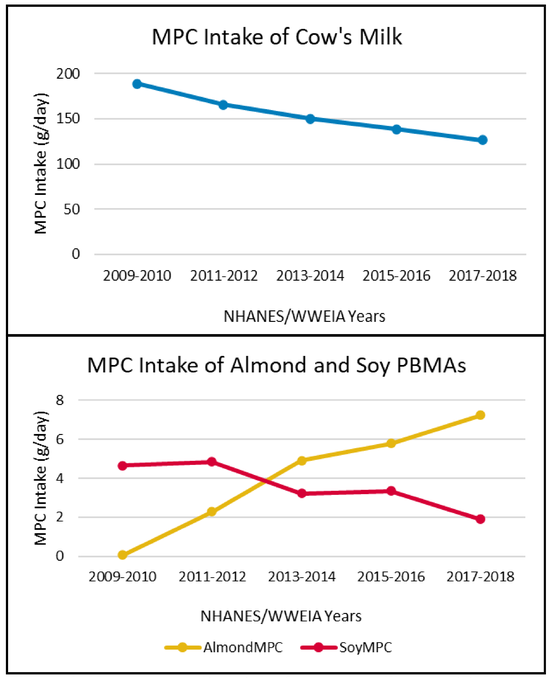


**Figure 1. Mean per capita intake for cow's milk, soy PBMA, and almond PBMA.**

## Acknowledgements

Thank you to the laboratory personnel at FDA's Kansas City Lab (KCL) for collecting the PBMA samples and performing all of the analyses and to the FDA investigators for collecting and shipping the cow's milk samples to KCL.

## Description

The 2020 DGA recommend consuming low-fat or fat-free milk and fortified soy beverages to help meet calcium requirements. Almond beverages are not included as part of the dairy group recommendations. The 2020 DGA suggest that other PBMAs such as almond may be able to help Americans meet their calcium requirements but overall they do not meet the nutritional requirements to meet the DGA dairy recommendations. Figure 2 shows the average calcium concentrations of three cow's milk products (N=27 each), one soy PBMA (N=3), and one almond PBMA (N=3) collected as part of the TDS. The three cow's milk products have very similar average calcium concentrations. The soy and almond PBMA are fortified with calcium and had higher average calcium concentrations than cow's milk. As the 2020 DGA suggest, fortified PBMAs are an option to meet necessary calcium needs.

Milk and dairy products are known sources of iodine (6). Iodine is particularly important during pregnancy and lactation because iodine intake can affect the neurocognitive development of the fetus (5). However, the concentration of iodine can vary widely in milk due to a variety of reasons making it difficult to know if one is consuming adequate or excess amounts of iodine (7). One reason for the wide range of iodine concentrations in milk may be that iodine is often used in solutions used in teat-dipping practices in dairy cows prior to milking (2).

Figure 3 shows the comparison of average iodine concentrations in three types of cow's milk and two PBMAs collected by the TDS. Average iodine concentrations in the three cow's milk types were 10 – 11 times higher than soy PBMA and 30 – 33 times higher than almond PBMA. This translates to average iodine concentrations in PBMAs that were about 9% (soy) and 2.5% (almond) that of average iodine concentrations in the three types of cow's milk. Bath et al. (1) compared UK iodine concentrations in cow's milk and PBMAs including soy and almond. Most milk substitutes were low in iodine with concentrations about 2% of that in cow's milk and they suggested that while many companies manufacturing PBMAs fortify with calcium, they may neglect to include iodine in their fortification (1) The iodine concentrations found in cow's milk samples from TDS are in agreement with iodine concentrations found in cow's milk in other countries (7).

Iron is a nutrient of public health concern. Iron is important for people of all age groups from infants to the elderly. Soy products and nuts are important sources of iron (5), but it is not clear if beverages made from soy and nuts contain meaningful iron concentrations. Based on label information, the soy and almond PBMAs analyzed by the TDS were not fortified with iron. Figure 4 shows the average iron concentrations for cow's milk and PBMAs. The average iron concentrations in soy PBMA were 54, 88, and 49 times greater than the average iron concentrations of whole, reduced fat, and skim milk, respectively. The average iron concentrations in almond PBMA were 23, 37, and 21 times greater than the average iron concentrations in whole, reduced fat, and skim milk, respectively. While Figure 4 indicates that soy PBMA has higher average iron concentrations that cow's milk, the iron concentrations in soy PBMA are small when considering sources of iron for nutrition purposes.

In addition to calcium, potassium is also a nutrient of public health concern for all age groups especially in older infants who often under consume potassium (5). Potassium is involved in the normal functioning of cells, regulation of heartbeat, proper functioning of muscles and nerves, and many other biological functions (3). Figure 5 shows the average potassium concentration for the three cow's milk types and two PBMAs. The average potassium concentrations of all three cow's milk types and soy PBMA were very similar. The average potassium concentration of almond PBMA was about half that of cow's milk and soy PBMA.

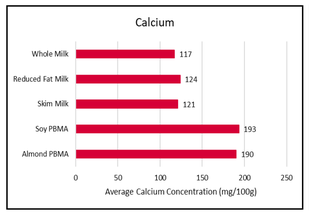


**Figure 2. Average calcium concentrations of TDS milk and PBMA samples**

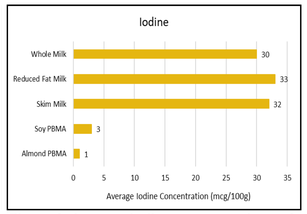


**Figure 3. Average iodine concentrations of TDS milk and PBMA samples**

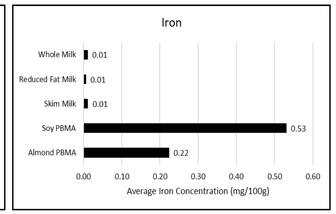


**Figure 4. Average iron concentrations of TDS milk and PBMA samples**

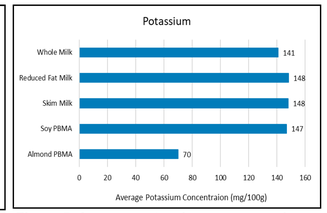


**Figure 5. Average potassium concentrations of TDS milk and PBMA samples**

## Conclusion

Based on the comparison between cow's milk and soy and almond PBMA, cow's milk remains a source of important nutrients like calcium, iodine, and potassium. PBMAs may be a source of iron and if fortified, a source of calcium. It is important to note that according to the 2020 DGA, iron found in soy products and nuts is non-heme iron which is less bioavailable than heme iron commonly found in meats and poultry. For individuals who are lactose intolerant or vegan, these alternative milk products are helpful additions to the diet. As PBMAs become more common, it is important to be aware of nutrient recommendations for those who frequently consume these products to ensure appropriate nutrition.

### References

1. Bath SC, Hill S, Goenage Infante H, Elghul S, Nezianya CJ, Rayman MP. 2017. Iodine concentration of milk-alternative drinks available in the UK in comparison to cows' milk. British Journal of Nutrition, 118: 525-532.
2. Borucki Castro SI, Berthiaume R, Robichaud A, and Lacasse P. 2012. Effects of iodine intake and teat-dipping practices on milk iodine concentrations in dairy cows. Journal of Dairy Science, 95: 213-220.
3. Harvard Health. 2019. The importance of potassium. Harvard Health Publishing Harvard Health Publishing. https://www.health.harvard.edu/staying-healthy/the-importance-of-potassium. Accessed 26 April 2022.
4. United States Department of Agriculture (USDA) and U.S. Department of Health and Human Services (HHS). 2000. Nutrition and Your Health: Dietary Guidelines for Americans. https://www.dietaryguidelines.gov/about-dietary-guidelines/previous-editions/2000-dietary-guidelines-americans. Accessed: 20 April 2022.
5. USDA and HHS. 2020. Dietary Guidelines for Americans, 2020-2025. https://www.dietaryguidelines.gov/. Accessed 20 April 2022.
6. USDA, FDA, and ODS-NIH. 2022. USDA, FDA and ODS-NIH Database for the Iodine Content of Common Foods. https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/methods-and-application-of-food-composition-laboratory/mafcl-site-pages/iodine/. Accessed: 2 May 2022.
7. Van der Reijden OL, Zimmerman MB, and Galetti V. 2017. Iodine in dairy milk: sources, concentrations and importance to human health. Best Practice & Research Clinical Endocrinology & Metabolism, 31: 385-395.