Nutritional and physiological evaluation of plant-based beverages

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Introduction: The nutrient composition and the physicochemical properties of 27 plant-based beverages on the Swiss market were analyzed to get an overview whether they can serve as milk alternatives.

Material and methods: In the first part of the project, the nutrient composition was analyzed using state of the art methods. Both the quality and quantity of the macronutrients: protein, fat and carbohydrates were investigated. Further, the vitamin and mineral composition was analyzed.
In the second part of the project the differences in physical properties of the beverages and especially their foamability were analyzed. Therefore, pH, partice size distribution, colour, viscosity, foamabiity (foam height, bubble size) werde determined. Of interest was also in particular the content of pyhtic acid that was also measured.

Results: The composition analysis revealed the vitamin and mineral contents of the beverages were very different. Cow's milk supplies all the vitamins studied in varying concentrations. In addition to vitamins C, A, and K2, which were not detected in plant-based beverages, milk is also a source of vitamin B2. While all these vitamins occur naturally in milk, some vitamins, such as vitamin B2, B12, E and D2, have been added to plant-based beverages. In particular, B2, B12 and D2 are (almost) absent in the non-fortified plant-based beverages. Calcium was added in 13 of 29 beverages. Tri- calcium phosphate was mostly used for fortification, and Lithothamnium calcareum (red algae) was also used in 5 beverages. However, the concentration in these beverages did not reach the level found in milk. Some beverages did not reach even 50% of the calcium content in milk. All vegetable beverages, except soy, had a much lower protein concentration than cow's milk. In addition, the proportion of essential amino acids to total amino acids was significantly higher in cow's milk. Furthermore, the simulated calculation of DIAAS shows that the protein quality of all plant-based beverages is much lower than that of cow's milk. Soy is the only product that comes close to the values of milk. The fat content was lower in the plant-based beverages compared to milk. An exception was an almond drink, which with one serving (2 dl) already covers 15.9% of the RDA (whole milk covers 11.5% of the RDA). Furthermore, a cashew and a hemp drink were also in the range of full-fat milk with 9% and 10% of the daily fat intake recommendation per serving, respectively. The composition of the vegetable fats, except coconut fat, shows that they contain more monounsaturated and polyunsaturated fatty acids compared to milk fat.

The consumer-relevant physicochemical and foamability analysis of the 27 plant-based beverages and UHT cow's milk showed that viscosities and pH values were similar or higher for PBBs than for cow's milk. PBBs were less white, and their mean particle sizes were generally significantly higher than those of cow's milk. Foam heights varied widely, ranging from 41.5 mm to 173 mm at room temperature (milk foam height: 134.8 mm) and 50.9 mm to 203.6 mm at 60°C (milk foam height: 179.3 mm). Our correlation analysis showed that phytic acid significantly affected foam height at 60°C, the relevant temperature for hot beverage consumption. This may be of interest as phytic acid may be reduced in these beverages for nutritional reasons

Conclusion:
The first generation of plant-based beverages show remarkable differences in their composition between each other and compared to milk. A complete replacement of milk with plant-based drinks without adjusting the overall diet can lead to deficiencies of certain important nutrients in the longer term.
The physicochemical measurements revealed that ome plant-based beverages are quite close to the properties of milk. However, some of the beverages contained stabilizers and emulsiifers that might affect the results. Interestingly, the content of phytic acid might have an effect on foamability. The influence of formulation and processing (reflected in the physical properties) on the functional properties showed interesting correlations and revealed new research questions. Our study shows several improvement possibilites in formulation and processing.for the next generation of plant-based beverages