Optimising the sensorial and nutritional value of plant-based milk alternatives

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Project Description: Plant based milk alternative (PBMA) sales increased 33% between 2015 and 2017 and almost a quarter (23%) of Brits are using these products, with many choosing oat-milk alternatives (OMA) that are considered the most sustainable. However, PBMAs have issues in both their sensory and nutritional profile. This project provides and exciting opportunity to substantially improve the sensory and nutritional profile of OMAs through a fundamental investigation and integration of sensory drivers of consumer acceptability and drivers for nutritional optimisation. The PhD student undertaking this project will belong to the food and sensory science research group at the University of Reading and the nutrition group at the University of Surrey, and benefit from our partnership with both the sensory and nutrition teams at Arla foods.

The sensory profile of OMAs considers the aroma, taste and mouthfeel of the beverage, and the compounds in the milk that result in such sensory characteristics. Oat milk-alternatives (OMAs) contain a variety of non-volatile tastants (sugars, polyphenolics) and volatile aroma compounds (predominantly lipid and Maillard derived) that contribute to the product's aroma and taste, and that are affected by thermal treatment. However, crucial to acceptability of OMAs is the extent of astringency and mouthdrying. Oats contain aventhramides (phenolic alkaloids) and avenacosides (saponins), which may contribute to astringency by binding to salivary proteins, thus reducing lubrication. In addition, protein fortification of beverages can lead to an alternative form of mouthdrying. Previous research at the University of Reading has shown that fortification of beverages with protein causes a drying sensation, building over repeated consumption, which correlates with the adhesion of protein to the oral cavity (mucoadhesion).

Dairy milk makes a substantial positive impact on the nutritional composition of western diets, particularly through the provision of high quality protein with a complete amino acid profile, calcium in a bioavailable form, and iodine. Unlike plant proteins, whey and casein are complete protein sources, which lead more readily to muscle synthesis. Dairy milk contains 3.4% protein compared to just 0.3 to 1.0 % (w/v) typical in commercial OMAs. Oat protein consists predominantly of globulin; characterised by its high lysine content making it nutritionally superior to other cereal proteins. Calcium in dairy milk is more bioavailable than from other sources; in plants absorption is hindered by oxalates and phytates. These anti-nutritional compounds form insoluble complexes reducing absorption. Oats have a number of positive nutritional factors; they are high in β-glucans, soluble fibre leading to slower absorption of carbohydrates with benefits such as improved blood sugar control, lowering cholesterol, improved immune function. These benefits need to be considered alongside the known positive effect that bovine milk proteins have on blood pressure and on insulin stimulation in relation to type 2 diabetes. Additionally, the aventhramides in oats have anti-inflammatory, antiatherosclerosis and anticancer effects whilst the avenacosides have been noted for cholesterol lowering effects.
By integrating our knowledge of food chemistry, sensory science and nutritional we propose that the student undertaking this project will optimise the sensory profile on OMAs whilst increasing protein content and calcium

bioavailability.

We propose a series of objectives where the student will be trained in key specialist skills. This will start with the development of OMAs varying in content of polyphenols, sterols and protein that will be heat treated before testing their sensory profile with a trained sensory panel. The volatile profile will be measured by GCMS (gas chromatography mass spectrometry) and statistically correlated to the sensory profile. To investigate the causes of astringency and mouthdrying we have methods to test mucoadhesion and binding to salivary protein. Working with all partners the student will explore methods to increase calcium bioavailability, including fermentation to degrade the anti-nutritional compounds, and investigate the influence of this on the sensory profile. In the final part of the PhD there will be the opportunity to carry out in-vitro digestion of different OMA preparations to investigate factors influencing calcium bioavailability.

The potential impact of this project is in enabling a substantial shift in the UK market from bovine milk to an oat based milk alternative, moving such products from niche to mainstream consumer commodity products.