Creating meat-like fibrous structures based on microalgal proteins with high moisture extrusion cooking

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Objective
Microalgae have high growth rates, can be cultivated in non-arable areas and are rich in proteins as well as micronutrients. In context of climate change, they are a promising non-animal protein source. However, the fabrication of consumer-accepted foods based on microalgae is challenging due to unfamiliar taste, texture and colour. Furthermore, our research illustrates that microalgae proteins have different characteristics compared to the plant proteins. This influences their structurability. Processes such as extrusion have to be adapted in order to structure microalgae proteins. Our research puts protein properties in context with processability.

Methods
Amino acids profiles, mineral compositions, protein size and solubility of soy protein concentrates (SPC), pea protein isolate and Auxenochlorella protothecoides biomasses (APB) have been examined and compared. A metric system to assess the ability of a raw material to build networks via hydrogen bonds, disulphide bridges, ionic bonds and hydrophobic interactions has been introduced. The effective propensity to texture was determined by extruding the characterised raw materials and subsequently analysing the extrudates with dynamic mechanical analysis.

Results & Conclusions
At fixed processing conditions, cutting force as well as double compression peak force decline by more than factor 3 for the 50:50 mixture of SPC and APB compared to pure SPC. The protein content of APB is with 47% lower than the protein content of SPC with 63%. However, even after adjusting the final protein content to a fixed value of 28% the peak force of dynamic mechanical analysis was still twice as high for pure SPC. This indicates that soy proteins have a stronger propensity to form fibrous structures. Our physicochemical analysis showed that all tested raw materials have comparable amounts of cysteine (0.01 mol/100g protein) and polar amino acids (0.23 mol/100g protein). However, the proteins of microalgae biomasses have fewer hydrophobic sidechains, are substantially smaller and have a higher water solubility. Thus, due to the reduced molecular size, more bonds are required to form a network of similar dimensions while the tendency to interact is lower because of high solubility. Increased processing time and higher temperature improved the texture of extrudates based on microalgal biomass.