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Nitrogen-to-protein conversion factor of seaweed varies with season

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This paper presents and evaluates the seasonal nitrogen budget of the sugarkelp, *Saccharina latissima* and discusses the importance of more specific nitrogen-to-protein conversion factors compared to commonly used factors. There has however recently been an effort to establish “a worldwide” nitrogen-to-protein conversion factors specific for seaweeds, as the traditional conversion factor of 6.25 overestimates their protein content [1,2], but without also considering possible seasonal variation of this conversion. This has also been addressed in the present study. The seaweed biomass was collected bi-monthly from commercially farmed *S. latissima* on droppers outside Horsens Fjord in Denmark from May 2013 to May 2014. Triplicates (each averaged by 10 specimen) were freeze dried and stored frozen until further analyses which included: Kjeldahl-N, amino acid composition by hydrolysis and determined by liquid chromatography with a mass spectrometry detector, and nitrate (NO₃⁻) concentration determined by ion chromatography. The total protein concentration of *S. latissima* varied from averages of 5.3% in July to 18.3% of dw in Nov/Jan when using the more recent nitrogen-to-protein factor of 5.38 [1]. However, the total protein concentration is only be 1.8% protein in May and 11.8% protein per dw biomass if estimated by summarizing amino acids. Comparing these data, the amino acids explained only ~23% of the protein content (by conversion factor) in the summer (May) and 97% during winter (Nov). The nitrate concentration of the seaweed varied significantly by season from zero in summer (between May and September) to 6.37% of dw biomass in November. The high nitrate biomass concentration due to higher seawater nitrate availability during the dark cold periods of winter in Denmark. The low nutrient availability during summer is most likely due to the high nutrient assimilation from microalgae, and remineralization and availability for e.g. macroalgae during winter. This study shows specific seasonal nitrogen-to-protein conversion factors, ranging from 0.96 in March 2014 to 4.57 in Nov 2013 with a yearly average of 2.49±1.07. This is substantially less than the traditional 6.25, the newer 5.38 [1] and the recently proposed 5.0 [2] analysed systematically from empiric data. These findings show the importance of developing more specific nitrogen-to-protein conversion factors in order not to overestimate protein concentrations, and thereby fool ourselves and others e.g. customers and consumers.

[1] Lourenço SO, Barbarino E, De-Paula JC, Pereira LODS, Marquez UM (2002) Amino acid composition, protein content and calculation of nitrogen-to-protein conversion factors for 19 tropical seaweeds. *Phycol Res* 50:233–241

[2] Angell AR, Mata L, de Nys R, Paul NA (2016) The protein content of seaweeds: a universal nitrogen-to-protein conversion factor of five, *J Appl Phycol* 28:511–524