Is nitrogen-to-protein conversion factor for seaweed dependent on season?

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Recently an effort has been made to establish nitrogen-to-protein conversion factors specific for seaweeds, as the tradition conversion factor of 6.25 overestimates their protein content [1,2]. Nevertheless, potential seasonal variation of this conversion factor has not yet been considered. This paper evaluates the seasonal nitrogen budget of *Saccharina latissima* and discusses the importance of more specific nitrogen-to-protein conversion factors, also taking season into account. The seaweed biomass was collected bi-monthly from commercially farmed *S. latissima* on droppers outside Horsen 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 hydrolysation and determined by liquid chromatography with a mass spectrometry detector, and nitrate ($NO3^-$) concentration determined by ion chromatography. Using the more recent nitrogen-to-protein factor of 5.38 [1] the total protein concentration of *S. latissima* varied from averages of 5.3% in July to 18.3% of dw in Nov/Jan. However, this would by summarizing amino acids only be 1.8% protein in May and 11.8% protein per dw biomass. 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). Looking into the nitrate composition of the seaweed, this varied significantly over the year from zero between May and September to 6.37% of dw biomass in November. Winter most likely being highest in nitrate biomass concentration since seawater nitrate is also more available during the dark cold periods in Denmark. This mainly due to the high nutrient assimilation from microalgae during summer, and remineralization and availability for e.g. macroalgae during winter. High nitrate may influence the ammonium included in Kjeldahl-N analyses. The seasonal nitrogen-to-protein conversion factors from this study show specific 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 literature. These data show the importance of developing more specific nitrogen-to-protein conversion factors and how researchers need a more critical approach to this, since 52% [2] just adapt the general and non-specific factors likely leading to overestimations of protein concentrations.

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[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