Seaweed fact

It’s often said that methane emissions from livestock come from their farts, but their farts aren’t actually as big of a problem as you might think. Their burps actually [make up 90 percent of their methane emissions](https://theconversation.com/seaweed-could-hold-the-key-to-cutting-methane-emissions-from-cow-burps-66498), and their farts are responsible for the remaining 10 percent.

So how do we get these animals to burp out less methane?

While researchers have been looking into seaweed’s potential for curbing livestock emissions [for a couple of years now](http://link.springer.com/article/10.1007/s10811-014-0487-z), the most exciting result came out [in late 2015](http://www.publish.csiro.au/an/AN15576), when a team from Australia found that a particular type of local seaweed, called Asparagopsis taxiformis, reduces methane production by more than 99 percent in the lab.

We have results already with whole sheep; we know that if Asparagopsis is fed to sheep at 2 percent of their diet, they produce between 50 and 70 percent less methane over a 72-day period continuously, so there is already a well-established precedent," one of the team, Rocky De Nys, [told ABC News.](http://www.abc.net.au/news/2016-10-19/environmental-concerns-cows-eating-seaweed/7946630?pfmredir=sm)

As agriculture researcher Michael Battaglia from Australia’s CSIRO [explains over at The Conversation](https://theconversation.com/seaweed-could-hold-the-key-to-cutting-methane-emissions-from-cow-burps-66498), the reason this particular type of seaweed is so effective is because it produces a compound called bromoform (CHBr3), which blocks methane production by reacting with vitamin B12 at the last step.

"This disrupts the enzymes used by gut microbes that produce methane gas as waste during digestion," [he says.](https://theconversation.com/seaweed-could-hold-the-key-to-cutting-methane-emissions-from-cow-burps-66498)

Most essential amino acids are deficient in seaweeds except the sulphur containing amino acids. Seaweeds concentrate minerals from seawater and contain 10–20 times the minerals of land plants. **They contain only small amounts of lipids (1–5%), but majority of those lipids are polyunsaturated n-3 and n-6 fatty acids.** Brown seaweeds have been more studied and are more exploited than other algae types for their use in animal feeding because of their large size and ease of harvesting. Brown algae are of lesser nutritional value than red and green algae, due to their lower protein content (up to approx. 14%) and higher mineral content; however brown algae contain a number of bioactive compounds. (<http://dx.doi.org/10.1016/j.anifeedsci.2015.09.018> )

**Analysis of Brown Seaweed**

Brown seaweeds have been particularly focussed on in recent years as potential biorefinery feedstocks. *Laminaria digitata* and *Saccharina latissima* are examples of brown seaweeds.

**Carbohydrate Composition of Brown Seaweed**

Laminarin is one of the polysaccharides found in brown seaweeds. It functions primarily as a carbohydrate reserve and consists of a mainchain of [glucose](http://www.celignis.com/analyte.php?value=7) with some side chains, also of [glucose](http://www.celignis.com/analyte.php?value=7). The degree of polymerisation of this polysaccharide is around 25, with either [mannitol](http://www.celignis.com/analyte.php?value=37) or [glucose](http://www.celignis.com/analyte.php?value=7) as the terminal sugar. [Mannitol](http://www.celignis.com/analyte.php?value=37) is also another important cabrohydrate reserve in brown seaweeds.   
  
Fucoidans are another major polysaccharide in brown seaweed. They consist of a backbone of sulphated [fucose](http://www.celignis.com/analyte.php?value=58) with additional substitutions involving [galactose](http://www.celignis.com/analyte.php?value=11) and [acetate](http://www.celignis.com/analyte.php?value=49).   
  
Alginic acid is a brown seaweed polysaccharide that contain boths [guluronic acid](http://www.celignis.com/analyte.php?value=47) and [mannuronic acid](http://www.celignis.com/analyte.php?value=47) in linear chains with the relative proportions of [mannuronic acid](http://www.celignis.com/analyte.php?value=47) to [guluronic acid](http://www.celignis.com/analyte.php?value=48) varying from ratios of 1.2 to 2.1 or greater. Within this linear chain these hexuronic acids tend to be arranged in C5 epimer blocks of one or the other, although less crystalline blocks involving both sugars can also be present.  
  
Cellulose is only present in minor amounds in brown seaweeds.

**Other Constituents and Seasonality in Brown Seaweed**

Ash can be a major constituent in brown seaweeds, reaching levels of over 35% in some cases. Protein can also be an important mass component.   
  
It is important to note that the composition of brown seaweed can vary substantially according to species and season. For instance, laminarin can be in concentrations of less than 1% or over 30%, depending on the season. Similarly, the amount of mannitol can vary by an order of magnitude, whilst alginate can be less than 20% or more than 40%, depending on the season. Due to this great variation in composition we strongly recommend that samples are analysed directly, for instance with one of our seaweed analysis packages, rather than using data from the literature.

Carbohydrate analysis

Soluble carbohydrate content (Karla J. McDermid∗ & Brooke Stuercke)

Soluble carbohydrateswere extracted from samples in 5% trichloroacetic acid, and concentrations determined by the phenolic sulfuric acid colorimetric method outlined in Dubois et al. (1956) and used on Mexican seaweeds by Robledo & Freile Pelegrin (1997). Percent soluble carbohydrate was calculated based on absorptions at 490 nm in a Beckman Coulter DU 640 spectrophotometer, and compared to a glycogen standard.

Carbohydrate analysis (Ghada F. El-Said & Amany El-Sikaily)

The total carbohydrate content was assayed by the phenol/sulfuric acid method (Dubois et al. 1956) after extraction with 2.5 N HCl. The results were calculated from a glucose standard curve using UV/Visible single beam spectronic 21 D Milton Roy spectrophotometer (Schuep and Schierle 1995). Carbohydrate content was expressed as mg/g dry weight.

Quantitatively the major polysaccharide of the brown seaweeds is alginic

acid.and sulphated polysaccharide are fulcan.

Carbohydrate analysis.

Monomeric sugars, 5-hydroxy-methyl-furfural (5-HMF), sugar alcohol mannitol and uronic acids in the hydrolysates were separated by a Dionex ICS-3000HPAEC-PADon a Dionex CarboPac PA20 column using the three eluents: A deionized water, B 200mMNaOH and C 1 MNaOAc in 200mM NaOH, all CO2 free and dosed in%volume/volume (v/v). Prior to

analysis, the samples were ?ltered through a 0.2 mm syringe tip ?lter and diluted appropriately in 200 mM NaOH. Chromato- graphic elution was carried out at a ?ow rate of 0.4 mL min?1 using B at 1%in A for 25min for separation of neutral sugars and sugar alcohol. Subsequently, separation of uronic acids was performed by a linear gradient from3 to 50%B plus 3 to 20%C in A for 20 min and completed with a linear gradient of C to 40%in 60% B and A within 5 min. The separated carbohydrates were detected using pulsed amperometric detection (PAD) with a gold working electrode. To increase the sensitivity of the detector a?er column addition of 200 mM NaOH was applied at a ?ow rate of 0.2mLmin?1 for the ?rst 25min andwith a linear gradient down to 20 mM NaOH for the following 25 min. The contents of glucose, xylose and mannose in the hydro-

lysates were also analyzed by borate-anion-exchange-chroma- tography with post column derivatization and UV detection at 560 nm (HPAEC-Borate) as described in detail by Sinner et al.24 and Willfoer et al.5

For identi?cation and quanti?cation of the

carbohydrates the Dionex so?ware Chromeleon 6.80 was used. Total uronic acids (UAs) in the hydrolysates were detected spectrophotometrically at 525 nm based on the method described by Filisetti-Cozzi and Carpita.25

Prior to the color

reaction samples were ?ltered through a 0.2 mm syringe ?lter and diluted appropriately in deionized water. Then 4 M sulfa- mate (prepared a?er Filisetti-Cozzi and Carpita25

) was added to

the sample in proportion 1 : 10. The H2SO4 concentration was adjusted to 80% w/w by mixing the sample with H2SO4 (analytical grade) containing 120mMNa2B4O7.A?er adding the color reagent m-hydroxydiphenyl (prepared a?er van den Hoo- gen et al.26) the absorbance, 525 nm, was monitored for 20 min and the maximum was reported. Background absorbance was determined individually and subtracted before the UA content was determined as galacturonic acid (GalA) equivalents from the corresponding GalA reference curve. For estimation of the recovery factor (RF) GalA was treated according to the relevant sulfuric acid hydrolysis procedure and GalA was then quanti?ed colorimetrically as described above.

HPAEC-PAD analysis a?er a 2-step treatment with ?rst 72% sulfuric acid for 1 h at 30 ?C and then 4% at 120 ?C for 40 min turned out to be the best methodology for quantitative deter- mination of the brown seaweed carbohydrate composition.