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REPORT ON AMS ANALYSIS
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RADIOCARBON RESULTS

ANSTO code	Sample Type	Submitter ID	$\delta^{13}C$	percent Modern Carbon		Percent Biobased carbon
			per mil	pMC	1σ error	
OZAL36	Plant material	1 fruit	-27.3	103.17	+/- 0.22	100%
OZAL37	Plant material	2 freeze dried	-27.3 +/- 0.1	102.73	+/- 0.19	100%
OZAL38	Other (organic)	3 ext in water	-28.2 +/- 0.2	102.85	+/- 0.24	100%
OZAL39	Other (organic)	4 synthetic mix	-12.7 +/- 0.3	101.60	+/- 0.20	100%

Method:
Radiocarbon is found in all living organisms. It is produced in the upper atmosphere and is taken up by plants during photosynthesis, and by animals that ingest the plants. As this occurs continuously during the lifetime of the plant, its radiocarbon content is similar to that of the atmospheric content at that time.
The test method follows the ASTM D6866-21 Standard 'Test Methods for Determining the Biobased Content of Solid, Liquid and Gaseous Samples Using Radiocarbon Analysis'. This method assumes that all organic carbon components in the analysed material are either from a recent biological material (currently above 100 pMC, percent Modern Carbon) or from petroleum derivatives (0 pMC). The presence of fossil carbon in a material is detected as it will dilute the material's biobased radiocarbon content. The percentage biological composition of a product (or % biobased) is determined by comparison of the radiocarbon content of the material to the atmospheric radiocarbon content at the time of growth. The percent biobased carbon result applies only to the analysed material and is a percentage of the total carbon content of the material.

Radiocarbon Result:
Calculation of % biobased carbon content was determined following the method outlined in ASTM D6866-21, section 13.4. The measured pMC value was divided by a reference value (or REF), [in this case an estimated average radiocarbon content value for the Southern Hemisphere for 2020 (Hua, 2021)] and multiplying the result by 100. The REF used = 101 ± 0.13 pMC (Q. Hua, 2021) and is based on data from Wellington, NZ (NIWA). Results are reported as % bio-based carbon content rounded to the nearest 1 unit. The ASTM D6866-21 recommends that an absolute error of 3 % is applied to this method.

The analysis of the four samples gives all have 100% biobased carbon content, indicating that all four samples are from natural sources which were grown recently.

It is possible that the lower pMC value for OZAL39 indicates that the carbon is sourced from plants that have grown in the Northern Hemisphere, as this has a slightly lower radiocarbon content compared to the Southern Hemisphere (Hua et al., 2021).

Stable Isotope Result:
The ratio of the stable isotopes of carbon, carbon-12 and carbon-13 is used to distinguish plants which have different photosynthetic metabolic pathways, due to differences in carbon fixation from atmospheric carbon dioxide. The different photosynthetic pathways give rise to C3, C4 and CAM plants. CAM plants are found primarily in arid areas, are less common and not considered further in this report.
The range of $\delta^{13}C$ values (in per mill, ‰) shows that these two plant types can be differentiated.

Pathway	$\delta^{13}C$ (‰)	Plant Type	Reference
C3	-20 to -37 ‰	terrestrial trees, shrubs, grasses, and herbs	Kohn M. J. (2010).
C4	-12 to -15 ‰	tropical grasses (e.g corn, millet, rice, sugarcane and sorgum) and sedges.	von Caemmerer, S. et al., (2014)

The $\delta^{13}C$ values for samples OZAL36, OZAL37 and OZAL38 indicate these fruits are from a C3 plant. The $\delta^{13}C$ value for sample OZAL39 indicates that the carbon in this material is sourced from C4 plants.

Notes:

1. $\delta^{13}C$ values relate solely to the graphite derived from the fraction that was used for the radiocarbon measurement. It is sometimes the case that the $\delta^{13}C$ of this fraction is not the same as that of the bulk material. Measurements are determined using EA-IRMS. Some $\delta^{13}C$ values may not have an associated uncertainty due to the limited number of determinations.
2. The definition of percent Modern Carbon can be found in M. Stuiver and A. Polach (1977).
3. Please use the ANSTO Code number in publications. The AMS facility should be referenced as Wilcken *et al*. (2015).
4. When publishing results please acknowledge the financial support for the Centre for Accelerator Science at ANSTO through the Australian National Collaborative Research Infrastructure Strategy (NCRIS).

References:

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