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Australopithecus at Sterkfontein, South Africa: Consumer of mammalian meat?

Significance:

It is now possible to quantify variability of nitrogen isotope ($\delta^{15}N$) ratios in tooth enamel bioapatite of hominin and non-hominin taxa from Plio-Pleistocene deposits in Sterkfontein's Member 4 in the Cradle of Humankind in South Africa. Lüdecke et al. (Science. 2025;387(6731):309–314) claim from both nitrogen and stable carbon isotopes that *Australopithecus* represented in this Member did not eat meat. However, this is based on hominins with primarily C3 diets. Here it is hypothesised that *Australopithecus* specimens with relatively high $\delta^{13}C$ would reflect some degree of carnivory associated with the consumption of meat such as that of ungulates (e.g. wildebeest) with C4 diets.

Lüdecke et al.[1] analysed nitrogen ($\delta^{15}N$) and stable carbon ($\delta^{13}C$) isotope ratios for a diversity of mammalian species (ungulates, primates and carnivores) from the Sterkfontein Caves in the Cradle of Humankind World Heritage Site. Remarkably, it has become possible to quantify variability of $\delta^{15}N$ in enamel bioapatite of *Australopithecus* and non-hominin taxa from Plio-Pleistocene samples from Sterkfontein's Member 4. Collagen is not preserved in samples of teeth or bone spanning the site's apparent range between 2 and 3.7 Ma[2-7] for Members 2–4 (generally consistent with the temporal range for South African *Australopithecus* suggested by van Holstein and Foley[8]), so the use of tooth bioapatite as an alternative source of material for quantifying $\delta^{15}N$ is welcome.

A claim by Lüdecke et al.[1] based on $\delta^{15}N$ in *Australopithecus* samples from Sterkfontein Member 4 (ASTM4) is that the hominins "did not consume substantial mammalian meat". This statement needs to be expanded with reference to a pioneering article by van der Merwe et al.[9] who obtained stable carbon isotope ratios from twice as many ASTM4 specimens. The combined $\delta^{13}C$ results from the two studies (n=20 teeth of South African *Australopithecus*) are given in Table 1, in addition to $\delta^{15}N$ ratios where they are available.

The new results can be assessed in relation to the following points:

1. Lüdecke et al.[1] analysed seven samples of ASTM4 *Australopithecus* with $\delta^{13}C$ ranging between −5.8 and −9.1 ‰, at the relatively low C3 end of the spectrum of $\delta^{13}C$.
2. Variability in $\delta^{13}C$ values for samples reported by Lüdecke et al.[1] and van der Merwe et al.[9] relate in part to palaeoenvironmental factors. The sample analysed by van der Merwe et al.[9] includes specimens with relatively high $\delta^{13}C$ values for ASTM4, reflecting C4 conditions.
3. From regression analyses, Thackeray et al.[10,11] reported relationships between $\delta^{13}C$ (x-axis) and $\delta^{15}N$ (y-axis) in collagen of extant African ungulates and primates. For those with primarily C3 diets ($\delta^{13}C$ for collagen < -16‰), there was a positive correlation between $\delta^{13}C$ and $\delta^{15}N$. From regression equations of the form $y = mx + c$, the correlation coefficients (r) ranged between 0.63 and 0.81 ($n > 100$). In the light of data for collagen samples with $\delta^{13}C < -16$‰, the following inference was made: $\delta^{15}N$ increases partly as a response to water stress.[10,11]
4. $\delta^{15}N$ values can be even higher than 10‰ in some cases for ungulate collagen.[10] Lüdecke et al.[1] associated high $\delta^{15}N$ values with carnivory, but high nitrogen isotope values in herbivores[10] obviously cannot be a result of meat consumption.
5. Thackeray et al.[10,11] reported an inverse relationship ($r = 0.84$) between $\delta^{13}C$ and $\delta^{15}N$ in collagen of ungulates with primarily C4 diets ($\delta^{13}C > -16$‰). Relatively high $\delta^{13}C$ values are associated with relatively low $\delta^{15}N$ nitrogen ratios which could be as low as 2‰. The study by Thackeray et al.[10] points to the possibility that this pattern might be due (to some extent) to a relatively low degree of water stress in certain C4-dominated savannah habitats.

On the basis of the data shown in Table 1, the mean $\delta^{13}C$ value for tooth apatite of South African *Australopithecus* (ASTM4, including *A. africanus* and *A. prometheus*), reported here for the first time as -6.35 ± 2.04‰ ($n = 20$), is not significantly different ($p = 0.05$) from a mean $\delta^{13}C$ value of -7.50 ± 2.64‰ ($n = 20$) for tooth enamel of *A. afarensis* from East Africa[12] (Table 2). It is hypothesised here that (1) the palaeodiets of specimens of *Australopithecus* with relatively high $\delta^{13}C$ values from both South Africa and East Africa (close to the C4 end of the spectrum) relate in part to the consumption of meat of ungulates with C4 diets, and (2) that $\delta^{15}N$ values for tooth enamel of australopithecines near the C4 end of the carbon isotope spectrum would be relatively high, associated in part with a trophic signal for the consumption of meat of grazing ungulates. Lüdecke et al.'s[1] claim that hominins "did not consume substantial mammalian meat" is based on only seven specimens of *Australopithecus* from Sterkfontein Member 4, associated primarily with C3-dominated values. However, their claim would not necessarily apply to australopithecines associated primarily with C4-dominated diets, including the consumption of meat of grazing ungulates.

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Table 1: Stable carbon isotope ratios ($\delta^{13}C$) for tooth enamel of *Australopithecus* (*A. africanus* and *A. prometheus*) from Sterkfontein reported by van der Merwe et al.[9] or Lüdecke et al.[1] Mean $\delta^{13}C$ value = -6.35 ± 2.04‰ ($n = 20$).

Specimen #	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	Reference
StW 73	–8.8		9
StW 276	–8		9
StW 252	–7.7		9
StW 211	–7.5		9
StW 304	–7.4		9
StW 14	–6.7		9
StW 315	–6.4		9
StW 309b	–6.1		9
StW 229	–5.8		9
StW 303	–4.4		9
StW 236	–3.7		9
StW 213i	–1.8		9
StW 207	–2		9
StW 47	–9.1	2.1	1
StW 96	–7.3	2.7	1
StW 148	–7	5.5	1
StW 285	–7	7.8	1
StW 397	–5.8	5.5	1
StW 402	–5.9	8.8	1
StW 555	–8.6	3.5	1

UCT database of carbon and nitrogen isotope ratios[10], focusing on extant African mammals, collated more than 30 years ago.

Declarations

I have no competing interests to declare. I have no AI or LLM use to declare.

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Table 2: Stable carbon isotope ratios ($\delta^{13}C$) for tooth enamel of *Australopithecus afarensis* reported by Wynn et al.[12] Mean $\delta^{13}C$ value = -7.50 ± 2.64‰ ($n = 20$).

Specimen #	$\delta^{13}C$ (‰)
A.L. 444-2	–8
A.L. 440-1	–7.6
A.L. 462-7	–6.4
A.L. 452-18	–2.9
A.L. 437-2	–6.6
A.L. 438-1h	–10.2
A.L. 309-8	–6.4
A.L. 423-1	–7.2
A.L. 309-8	–4.3
A.L. 333-52	–8.6
A.L. 207-17	–4.3
A.L. 411-1	–7.7
A.L. 225-8	–6.7
A.L. 125-11	–13
A.L. 660-1	–9.6
A.L. 249-27	–10
A.L. 293-3	–10.7
DIK2-1	–4.3
DIK40-1	–10.6
DIK 49-12	–4.9

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