

# Spinach, apples increase important molecule for cardiovascular and cognitive health

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"In addition, spinach, and the apple + spinach combination, significantly improved markers of NO in saliva and urine as well," Dr Bondonno says. Credit: sharyn morrow

Scientists have discovered that consuming apples and spinach acutely increases nitric oxide (NO) status, an important molecule for cardiovascular and cognitive health through its affect on blood flow and blood vessel function.

UWA School of Medicine and Pharmacology expert Dr Catherine Bondonno was interested in testing whether flavonoid-rich apples and nitrate-rich [spinach](#) would increase markers of NO in the body, thereby leading to an improvement in cognitive function and mood.

"An imbalance of NO has been found in cardiovascular disorders and certain pathological conditions in the brain, [and] it appears cardiovascular disease or the presence of risk factors for [cardiovascular disease](#) contribute to [cognitive decline](#)," she says.

"A diet high in fruit and vegetables is associated with improved cardiovascular and [cognitive health](#).

"Flavonoids and nitrate, two components of a fruit and vegetable diet, are currently generating interest as research shows they could improve health by increasing NO in the body."

They recruited 30 healthy female and male volunteers, screened through a medical history questionnaire, electrocardiography, BMI, height and weight, blood pressure, and fasting blood samples.

Volunteers were randomly assigned into one of four interventions—a) [apple](#): high flavonoid low nitrate; b) spinach: low flavonoid high nitrate; c) apple + spinach: high flavonoid high nitrate; d) control: low flavonoid low nitrate.

The active interventions (a, b and c) involved consuming 200g of Pink Lady apple skins homoeogenised with the flesh, 200g of spinach, or both, at lunch respectively.

The researchers measured plasma NO status through S-nitrosothiols and other nitroso species (RXNO), as well as nitrate and nitrite levels in plasma, urine and saliva.

Cognitive performance and mood were determined using the Cognitive Drug Research battery and the Bond-Lader mood scale respectively.

"Compared with the control, apples and spinach increased markers of NO in the plasma," Dr Bondonno says.

"In addition, spinach, and the apple + spinach combination, significantly improved markers of NO in saliva and urine as well."

While they did not observe any improvement or deterioration in cognitive function or mood, the study utilised healthy volunteers with normal cognitive function, and the researchers were only assessing short-term effects.

"It doesn't rule out the possibility of an improvement with long-term intake of spinach and apples, an effect in a group of volunteers with a lower cognitive performance, or an improvement with harder cognitive tasks," she says.

Dr Bondonno is now interested in examining the long-term intake effects of apples and spinach on NO status and cognitive function.

**More information:** "Flavonoid-rich apples and nitrate-rich spinach augment nitric oxide status and improve endothelial function in healthy men and women: a randomized controlled trial." Bondonno CP, Yang X, Croft KD, Considine MJ, Ward NC, Rich L, Puddey IB, Swinny E, Mubarak A, Hodgson JM. *Free Radic Biol Med*. 2012 Jan 1;52(1):95-102. [DOI: 10.1016/j.freeradbiomed.2011.09.028](https://doi.org/10.1016/j.freeradbiomed.2011.09.028) . Epub 2011 Oct 1.

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