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Metabolic effects of dark chocolate consumption on energy, gut microbiota, and stress-related metabolism in free-living subjects

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Abstract

Dietary preferences influence basal human metabolism and gut microbiome activity that in turn may have long-term health consequences. The present study reports the metabolic responses of free living subjects to a daily consumption of 40 g of dark chocolate for up to 14 days. A clinical trial was performed on a population of 30 human subjects, who were classified in low and high anxiety traits using validated psychological questionnaires. Biological fluids (urine and blood plasma) were collected during 3 test days at the beginning, midtime and at the end of a 2 week study. NMR and MS-based metabonomics were employed to study global changes in metabolism due to the chocolate consumption. Human subjects with higher anxiety trait showed a distinct metabolic profile indicative of a different energy homeostasis (lactate, citrate, succinate, trans-aconitate, urea, proline), hormonal metabolism (adrenaline, DOPA, 3-methoxy-tyrosine) and gut microbial activity (methylamines, p-cresol sulfate, hippurate). Dark chocolate reduced the urinary excretion of the stress hormone cortisol and catecholamines and partially normalized stress-related differences in energy metabolism (glycine, citrate, trans-aconitate, proline, beta-alanine) and gut microbial activities (hippurate and p-cresol sulfate). The study provides strong evidence that a daily consumption of 40 g of dark chocolate during a period of 2 weeks is sufficient to modify the metabolism of free living and healthy human subjects, as per variation of both host and gut microbial metabolism.

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Rezzi S, Ramadan Z, Martin FP, Fay LB, van Bladeren P, Lindon JC, Nicholson JK, Kochhar S. J Proteome Res. 2007 Nov;6(11):4469-77. doi: 10.1021/pr070431h. Epub 2007 Oct 12. PMID: 17929959

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