proceedings

MDPI

Proceedings

Role of a Polyphenol-Rich Dietary Pattern in the Modulation of Intestinal Permeability in Older Subjects: The MaPLE Study †

Stefano Bernardi [1], Cristian Del Bo' [1], Simone Guglielmetti [1], Antonio Cherubini [2], Paul Kroon [3], Benjamin Kirkup [3], Nicole Hidalgo Liberona [4,5], Gregorio Peron [4,5], Raúl González-Domíinguez [4,5], Cristina Andrés-Lacueva [4,5] and Patrizia Riso [1,*]

[1] Department of Food, Environmental and Nutritional Sciences (DeFENS), Università degli Studi di Milano, 20133 Milan, Italy; stefano.bernardi@unimi.it (S.B.); cristian.delbo@unimi.it (C.D.B.); simone.guglielmetti@unimi.it (S.G.)

[2] IRCCS INRCA, Geriatria, Accettazione Geriatrica e Centro di Ricerca per l'Invecchiamento, 60127 Ancona, Italy; a.cherubini@inrca.it

[3] Quadram Institute Bioscience, Norwich Research Park, Norwich NR4 7UG, UK; paul.kroon@quadram.ac.uk (P.K.); benjamin.kirkup@quadram.ac.uk (B.K.)

[4] Biomarkers and Nutrimetabolomics Laboratory, Department of Nutrition, Food Sciences and Gastronomy, XaRTA, INSA, Faculty of Pharmacy and Food Sciences, University of Barcelona, 08028 Barcelona, Spain; n.hidalgoliberona@ub.edu (N.H.L.); gregorio.peron@ub.edu (G.P.); raul.gonzalez@ub.edu (R.G.-D.); candres@ub.edu (C.A.-L.)

[5] CIBER Fragilidad y Envejecimiento Saludable (CIBERfes), Instituto de Salud Carlos III, 28029 Madrid, Spain

* Correspondence: patrizia.riso@unimi.it; Tel.: +39-0250-31-6726

† Presented at Natural Products and the Hallmarks of Chronic Diseases—COST Action 16112, Luxemburg, 25–27 March 2019.

Published: 16 April 2019

Keywords: intestinal permeability; zonulin; inflammation; microbiota; polyphenols; older subjects

1. Introduction

The inevitable rise of the proportion of people aged >65 years worldwide is paralleled by an increased burden of chronic diseases often associated with low-grade systemic inflammation. Recent findings suggest a link between inflammation and intestinal permeability (IP), a condition characterized by an impairment of intestinal barrier function which enables the translocation of dietary and bacterial factors into the blood activating the host immune system [1,2]. Dietary components can be significant modulators of inflammation and IP, and can also affect the intestinal microbial ecosystem. In the context of a diet-microbiota-IP axis in older subjects, dietary bioactives such as polyphenols may play a significant protective role due to their widely reported antioxidant and immunomodulatory properties and potential to regulate IP [3–6].

2. Material and Methods

The MaPLE project involves a multidisciplinary approach developed to ascertain the impact of a polyphenol-rich dietary pattern on a large number of markers in a target group of older subjects living in a controlled setting (i.e., nursing home).

A controlled, randomized cross-over dietary intervention study (8-week polyphenol-rich diet versus 8-week control diet) was undertaken. Markers of IP, inflammation, oxidative stress and vascular function and assessments of gut microbiota structure and function were quantified in serum,

urine and/or fecal samples. In addition, bacterial DNAemia, and serum/urine metabolomics were assessed. In vivo with a dietary mixture similar to the human study and in vitro studies with isolated polyphenols were carried out to investigate mechanisms of action.

3. Results & Discussion

The dietary intervention has been completed and as expected, IP was relatively high in this cohort of older participants, as assessed by serum levels of zonulin at baseline. Quantification of changes in various markers in response to the high polyphenol diet compared to the normal polyphenol diet are being completed and will provide evidence of the putative beneficial effect of increased polyphenol consumption in this target population.

Funding: This research was supported by a grant by Ministero delle Politiche Agricole, Alimentari, Forestali e del Turismo (Mipaaft), MINECO-Grant MAPLE-PCIN-2015-238, Biotechnology and Biological Sciences Research Council (UK) Grant BB/R012512/1 and the European Joint Programming Initiative "A Healthy Diet for a Healthy Life" (JPI- HDHL: http://www.healthydietforhealthylife.eu/) MaPLE. CAL thanks 2017SGR1546 from AGAUR, CIBERFES (co-funded by the FEDER Program from EU) and ICREA Academia award 2018.

Acknowledgments: This publication is based upon work from COST Action NutRedOx-CA16112 supported by COST (European Cooperation in Science and Technology).

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results".

References

1. Thevaranjan, N.; Puchta, A.; Schulz, C.; Naidoo, A.; Szamosi, J.C.; Verschoor, C.P.; Loukov, D.; Schenck, L.P.; Jury, J.; Foley, K.P.; et al. Age-Associated microbial dysbiosis promotes intestinal permeability, systemic inflammation, and macrophage dysfunction. *Cell Host Microbe.* **2017**, *21*, 455–466.
2. Bischoff, S.C.; Barbara, G.; Buurman, W.; Ockhuizen, T.; Schulzke, J.D.; Serino, M.; Tilg, H.; Watson, A.; Wells, J.M. Intestinal permeability—A new target for disease prevention and therapy. *BMC Gastroenterol.* **2014**, *14*, 189.
3. Del Rio, D.; Rodriguez-Mateos, A.; Spencer, J.P.; Tognolini, M.; Borges, G.; Crozier, A. Dietary (poly)phenolics in human health: Structures, bioavailability, and evidence of protective effects against chronic diseases. *Antiox. Redox Sig.* ***2013***; *18*, 14, 1818–1892.
4. Taverniti, V.; Fracassetti, D.; Del Bo', C.; Lanti, C.; Minuzzo, M.; Klimis-Zacas, D.; Riso, P.; Guglielmetti, S. Immunomodulatory effect of a wild blueberry anthocyanin-rich extract in human Caco-2 intestinal cells. *J. Agric. Food Chem.* **2014**, *62*, 8346–8351.
5. Suzuki, T. Regulation of intestinal epithelial permeability by tight junctions. *Cell Mol. Life Sci.* **2013**, *70*, 631–59.
6. Ruan, Z.; Liu, S.; Zhou, Y.; Mi, S.; Liu, G.; Wu, X.; Yao, K.; Assaad, H.; Deng, Z.; Hou, Y.; Wu, G.; Yin, Y. Chlorogenic acid decreases intestinal permeability and increases expression of intestinal tight junction proteins in weaned rats challenged with LPS. *PLoS ONE* **2014**, 9, e97815.