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This opinion was made in response to the request of prof dr hab. Agnieszka Kita, Chairman of the Board of Discipline Food and Nutrition Technology, Wrocław University of Environmental and Life Sciences. The review was based on a doctoral dissertation given by Marina Cano Lamadrid, M.Sc.

Marina Cano Lamadrid, M.Sc., has prepared a doctoral dissertation entitled: "Research, Development and Innovation of Hydrosustainable products based on pomegranate". The doctoral dissertation consists of 165 pages. The author documents it with 2 figures, 3 tables and 107 references of domestic and foreign literature. In addition, the dissertation contains a comprehensive summary of the work in Polish, English and Spanish language as well as a list of publications and copies of publications on the subject of the doctoral dissertation, which significantly increases the value of the work. The doctoral dissertation consists of a manuscript in English and 7 publications published in renowned world journals with a significant IF value:

Journal of the Science of Food and Agriculture, 98: 3098-3108 (2018)	IF 2.642
Journal of Food Science, 82: 1820-1826 (2017)	IF 2.067
Journal of Food Science, 84: 886-894 (2019)	IF 2.077

Food Chemistry, 232: 306-315 (2017)	IF 5.477
Journal of Food Science, 83: 3085-3091 (2018)	IF 2.081
Journal of the Science of Food and Agriculture, 98: 5731-5741 (2018)	IF 2.642
LWT- Food Science and Technology, 96, 322-328 (2018)	IF 3.970

Total: 20.956

The scientific object of research was pomegranate (*Punica granatum* L.) belongs to the Punicaceae family. The tree is grown in many subtropical countries especially in the Mediterranean region. It is also grown extensively in India, Pakistan, Afghanistan, Iran, Saudi Arabia and in the subtropical areas of South America. Pomegranate fruits are mainly used fresh in the Mediterranean countries, but mostly for making preserves. Pomegranate fruits belong to the crops with a significant low water demand. In times of water supply problems, especially in plant cultivation, it is an important feature of these plants. In times of the need for sustainable management of water resources, there is a need to develop pomegranate cultivation techniques that will allow to obtain a satisfactory fruit yield with high biological value and the content of biologically active compounds. The main aim of the first article was to develop knowledge on the simultaneous effects of deficit irrigation (during fruit growth and ripening) and crop load on yield and fruit quality in the two most popular pomegranate cultivars in Spain: ME and Wond. The quality was studied by evaluating (i) physical characteristics, (ii) chemical characteristics and (iii) descriptive sensory attributes of fruit. The main results showed, that thinning was effective in increasing the size and weight of fruits. Unfortunately, neither punicalagin, nor total polyphenolic content were positively affected by irrigation and thinning. T1A1 Wond fruits were characterized by high sugar content (glucose and fructose), together with high fruit size and weight. Furthermore, T1A1ME fruits were characterized by high contents of alcohols and monoterpenoids (providing vegetal and citric flavor notes) and key sensory attributes (color, fruity and fresh pomegranate). Main and the most important conclusion of first described experiment was **to use the treatment T1A1 [simultaneous combination of deficit irrigation during fruit growth and ripening (T1) and thinning (A1)], although the positive results were cultivar-dependent.**

The main aim of the second manuscript was to compare the phytochemical content (total polyphenols content, punicalagin isomers and ellagic acid) and antioxidant capacity measured

by three methods of different commercial pomegranate products (capsules and supplements and juices and nectars) available on the international market. The experimental data

showed high variability. **The main conclusion was that there is a need for labeling “standardization” of these products. The contents of the key compounds as polyphenols and ellagic acid should be declared on product labels, as indicators of the potential health benefits, and should replace subjective functional descriptions.** It is worth to underline, that presented results have a practical meaning and could lead to standardization of pomegranate products available of market.

The main aim of the third publication was to compare the phytochemical contents in pomegranate juice based drinks (pure, 100 % pomegranate as well juices with different percentage of pomegranate juice) with their label information. Phytochemical content (total polyphenol content, punicalagin isomers content, ellagic acid, titratable acidity, color density, polymeric color, and sensory profile were used as reference parameters. The obtained results showed a high variability in bioactive compounds content among pomegranate juices based drinks available on the Spanish market and the fact that the presence of pomegranate in the ingredient list does not guarantee the presence of bioactive compounds. In the present situation, studies aiming to evaluate the health properties and effects of pomegranate-based products are highly jeopardize by the high heterogeneity in the occurrence of their bioactive compounds. Producers' organizations (for example, DO Regulating Councils) may benefit from harmonizing pomegranate products labelling, so they may fulfill consumer expectations and may be ready if health claims are finally authorized for these products.

The main aim of the four publication was to evaluate the physico-chemical and sensory properties of the dried arils prepared using first osmotic dehydration (OD), with selected fruit juice concentrates, and later a combined drying technique [convective pre-drying (CPD) and vacuum-microwave finish drying (VMFD)] for dehydration of pomegranate arils cultivar 'Mollar de Elche'. The drying kinetics, quality parameters (anthocyanin content, antioxidant capacity, colour, rehydration ratio), and descriptive sensory profile were studied. The obtained results showed that osmotic dehydration using 'Wonderful' pomegranate and chokeberry concentrated juices improved the quality of dried 'Mollar de Elche' pomegranate arils in terms of rehydration rate, antioxidant capacity, colour, and sensory profile; however still further research is needed to fully optimize this combined drying treatment because the freeze-dried sample still had higher anthocyanin content and better instrumental colour parameters. Similar

as previous it is worth to pointed that described experiment has a practical meaning for consumers. Improving the quality of dried pomegranate arils must increase the popularity of this product, even in groups with reduced fruit consumption, such as teenagers and children, leading to higher consumer acceptance, consequently higher product demand, and finally higher benefits for the farmers and industry.

The main aim of the fifth presented by Authors article described determination of consumer insights about dried pomegranate arils using different technologies and to link the consumer data with descriptive and volatile composition data. The results might be used by pomegranate derivative or dried fruits companies to improve their procedures and make more successful products that meet consumers' demands. The obtained results showed, that consumers' positively opinion on the improvement of the volatile profile and sensory quality of developed dehydrated pomegranate arils if compared with a commercial product. The study of consumers' data and its relationship with analytical and descriptive sensory data showed the main liking drivers: high esters and low furan compounds content, high fruity and sweet attributes, and low seed-hardness.

The main aim of six's manuscript presented by Marina Cano Lamadrid, M.Sci was to determine the effect of minor Mediterranean crops (figs, jujubes or quinces) on the quality and functional properties of smoothies based on pomegranate juice, two cultivars: 'Mollar de Elche' and 'Wonderful'. The parameters under study were: physicochemical parameters (color); chemical composition (minerals, sugars and organic acids); phytochemical contents (vitamin C, anthocyanins, flavan-3-ols, flavonols, hydroxycinnamic acids and polymeric procyanidins); and antioxidant capacity (measured by ORAC assay). The obtained results and main practical conclusion of provided experiment showed, a positive effect of the addition of minor crops (fig, jujube and quince) was observed on the nutritional and functionality of the novel pomegranate smoothies. Moreover, the addition of jujube contributed to an enrichment of the final smoothies in vitamin C and organic acids, while an increase of pectin content was found in fig and quince pomegranate based smoothies. Therefore, the blend of minor Mediterranean crop purées with pomegranate juice to produce smoothies is a good strategy to promote the consumption of these healthy but underutilized fruits.

The last but, not least article presented as integral part of evaluated doctoral thesis presented by Marina Cano Lamadrid, M.Sci, was about study how storage conditions influence on the color, polyphenols content, and antioxidant activity of pomegranate smoothies. The study was

completed by evaluating the effect of ratio purée : juice, pomegranate cultivar ('Mollar de Elche' and 'Wonderful'), and fruit purée (quinces, jujubes, and figs) on the quality of the prepared experimental fruits smoothies. The obtained results showed that examined smoothies before storage presented high values of total polyphenolic content. A positive effect of the different ratio purée : juice, the 'Wonderful' pomegranate juice storing at low temperature was found on total polyphenolic content procyanidins and phenolic acids as well quality of smoothies being only a small reduction in fig, jujube and quinces smoothies, respectively.

In general. The doctoral thesis, presented and published by Marina Cano Lamadrid, M.Sci, it meets all the requirements for doctoral dissertations. I am impressed by the amount of research and measurements carried out as part of the implementation of individual scientific articles. An important and integral feature of the presented doctoral dissertation is not only its very high scientific value, but as well its practical application, which significantly increases the value of the work.

Therefore I highly appreciate the doctoral dissertation submitted for evaluation. I ask the High Discipline Council Wrocław University of Environmental and Life Sciences to admit the dissertation to further steps of the procedure. At the same time, I hereby request that a doctoral dissertation be awarded.

The Sincerely yours

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