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Ph.D. Thesis Evaluation Report

Thesis Title: Research, Development and Innovation of Hydrosustainable products based on pomegranate

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1) Introduction

Water scarcity is a worldwide problem that leads to environmental and economic issues. Agriculture is one of the main consumers of water for irrigation and fertilization. Recently, there is a continuous growing demand for novel, healthy and sustainable food products. The PhD thesis of **Marina Cano Lamadrid** is devoted to investigations the novel pomegranate-based products develop includes the functional and organoleptic properties of hydrosustainable production-system and which are adapted to the needs and requirements of European consumers. Additionally, the fruit quality in the two most popular pomegranate cultivars in Spain, Mollar de Elche and Wonderful obtained from deficit irrigation and crop load treatments, and the phytochemical content and antioxidant capacity of different commercial pomegranate based products were elucidated. Finally, novel dehydrated arils and smoothies were developed using hydrosustainable pomegranate fruits and analyzed; and pomegranate dried arils prepared using osmotic dehydration and later a combined drying technique for dehydration of pomegranate arils cv. *Mollar de Elche*. The novelty and scientific level of the thesis are very good, considering the importance of the research subject, market requirements and ecological demands.

2) Contents of the thesis and evaluation

The thesis consists of 4 main blocks in total. As a result of the dissertation, a total of 7 articles were produced in these blocks, which were published in high-impact factor journals.

***BLOCK I*, Farming of hydroSOStainable pomegranate fruits:** The principal objective of first block was to elucidate deeper knowledge on the simultaneous effects of sustained deficit irrigation-SDI (during fruit growth and ripening) and crop load (thinning) on yield and fruit quality of Mollar de Elche and Wonderful fruits by evaluating fruit

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physochemical properties, and descriptive sensory attributes. Thinning was found to be effective in increasing the size and weight of fruits, but polyphenolic content were not positively affected by irrigation and thinning treatments. In the light of this block, soft deficit irrigation was proposed for pomegranate production and one article was published (**Publication 1**. Influence of deficit irrigation and crop load on the yield and fruit quality in Wonderful and Mollar de Elche pomegranates. *Journal of the Science of Food and Agriculture,* 98: 3098-3108). Experimental conditions and treatments in this block are well prepared, the methods of analysis used fort he samples are sensitive and convenient.

***Block II*, Overview of commercial pomegranate products**: This block was provided an overview of the emerging functional-novel foods with pomegranate-based products in the sector and an emphasis on a consumer-oriented food products compositions were highlighted. On the other hand, it confirms the accuracy of product label information. In this block, commercial pomegranate products, including capsules and supplements, and, juices and nectars were assayed by comparing the labelling information with the real phytochemical contents and their antioxidant potentials. As a results, a high variability in the content of bioactive in the samples were found. As a result of this block, companies that produce these functional products have been advised to optimize their production methods and standardize the label information. As a result of these block studies, two articles were produced (**Publication 2**: The phytochemical composition of commercial pomegranatebased products has been studied. *Journal of Food Science*, 82: 1820-1826; **Publication 3**: A critical overview of labeling information of pomegranate juicebased drinks has been studied -*Journal of Food Science*, 84: 886-894).

***Block III*, Preparation of dehydrated pomegranate arils:** The aim of this block was to elucidate the drying kinetics, quality amd sensory parameters of the dried arils obtained cv. Mollar de Elche-ME, prepared using osmotic dehydration with selected fruit juice concentrates (apple, Wonderful pomegranate and/or chokeberry) and comparing results with those obtained after using a combined drying technique [convective pre-drying (CPD) and vacuum-microwave finish drying (VMFD)] for dehydration of pomegranate arils cultivar ME. As a results of this part, the best results were obtained for a sample dried using pre-osmotic dehydration in Wonderful concentrate pomegranate juice followed by a combined drying technique. Another part of the doctoral dissertation containing practical results for food industry is this block. Both new products (dried arils) were obtained for pomegranate fruits and drying was studied with the most optimal parameters. Drying methods and analysis methods used are appropriate. Two very valuable articles have also been produced from the findings obtained here (**Publication 4**: The effect of osmotic

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dehydration pre-treatment and combined drying method on physico-chemical and sensory properties of pomegranate arils, cultivar Mollar de Elche, Food Chemistry, 232: 306-315. **Publication 5**: Consumers' opinion on dried pomegranate arils to determine the best processing conditions has been studied. Journal of Food Science, 83: 3085-3091).

Block IV, Preparation of pomegranate-based smoothies: In this last block, the production of smoothies, which are highly loved and consumed by consumers with different type of fruits, has been investigated. Briefly, the addition fig, jujube, or quince purée to both pomegranate juices as two ratios 40:60 and 60:40 were prepared the smoothies and chemical and bioactive compositions of the samples and effect of storage conditions were studied. As a result of the part, it was emphasized that the fruit types strongly affect the composition of smoothies, and the most popular example is samples stored in 4C prepared in quince puree with Wonderful juice. Two different articles were produced with the results obtained in this block. (**Publication 6**: Phytochemical composition of smoothies combining pomegranate juice and *Ficus carica, Cydonia oblonga*, and *Ziziphus jujube* purées. Journal of the Science of Food and Agriculture. 98: 5731-5741. **Publication 7**: The effect of formulation and storage conditions on pomegranate smoothie phenolic composition, antioxidant capacity and color. LWT- Food Science and Technology. 96: 322-328).

3) Conclusion

The reviewed thesis fulfills all requirements posed on theses aimed for obtaining PhD degree. It seems to be an interesting topic for scientists working on fruit processing and food chemistry. All experiments are well arranged and measurements techniques and methods are correctly applied with a deep and rich analysis. It is generally well presented and very interesting to read. The explanations are suitable and focused on the relevant topics.

Therefore, I strongly recommend to accept the submitted work as the dissertation PhD thesis and to award the PhD degree to the candidate due to the following aspects: scientific novelty, an extensive range of research, meritorious presentation and discussion of obtained results, outstanding scientific activity confirmed by excellent seven publications published in high impact factor journals.

This thesis is ready to be defended orally, in front of scientific committee.

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