



to Dean's Office,  
Wrocław University of  
Environmental and Life Sciences

**Review Doctoral dissertation**

**"Novel Carrot Snacks with Desired Health Benefits" - MSc Emel Hasan Yusuf**

***Relevance in the specific field***

The purpose of this PhD thesis was to develop innovative food products using different carrot varieties. Taking into account the market request of new healthy food, the global consumption of carrots and the importance to enhance the biodiversity, the purpose of the project is very important for the potential impact in the food industry, especially in the field of the food supplements and enriched foods.

***Thesis organization***

Thesis is structured with a summary that reports in an organic way the data published in 5 articles that are reported in original in the Annex.

***Introduction, state-of-the-art***

The thesis starts with a good and updated review of the literature and introduce nicely the following experimental part. Introduction is very comprehensive containing relevant information on carrot varieties, from the most consumed worldwide (such as orange carrot) to the less known varieties. Information is appropriate to understand the goals of the research, applied methodologies and to put the current research into the appropriate wider context. The literature cited is adequate.



### *Scientific value*

Experimentation was well planned and performed, reporting a detailed analytical investigation, from the physical-chemical evaluation to the nutraceutical implications (anti-aging, anti-obesity, anti-diabetes potential). Thesis is clear, well organized and of good quality, and final results justify the experimentation. The scientific value of the thesis is supported also by data publication (5 papers and oral/poster presentations at national and international conferences) and a patent request.

### *Methodology*

Experimentation is briefly described in first part of thesis and in a more detailed way in the published papers (chemicals and reagents, samples represented by 12 carrot varieties with different sizes and colours, description of used methodologies). Moreover, biological activities, sensorial characteristics and statistical analysis were reported. All the analytical techniques are suitable for achieving the objective of the work by means of a comprehensive approach.

### *Results and discussion*

Results and discussion are described both in Chapter 4 and in the related papers, where they are presented also in the form of figures and tables.

Paragraph 4.1. (Publication 1) and Paragraph 4.2. (Publication 2) were dedicated to compare 12 carrot varieties with different colours and sizes in terms of their bioactive contents (including qualification and quantification of sugars, organic acids, minerals, and bioactive compounds by UPLC) and health-promoting properties (*in vitro* effect on  $\alpha$ -amylase,  $\alpha$ -glucosidase, lipase, and cholinesterase activities). The results showed that different-sized purple carrot varieties can provide high contents of polyphenolic compounds to combat oxidative stress-related diseases, and may increase the effectivity of the sensorial characteristics of carrot-based novel, functional foods. Moreover, some investigated compounds were not assessed in the scientific literature and they were analysed for the first time in the context of their impact on health-promoting properties in this PhD study.



Paragraph 4.3. (Publication 3) was focused on the possibility to use the different sizes and colours of carrots for the production of juices investigating bioactive compounds, nutritional quality, pro-health properties, and sensory evaluation. Interesting results for purple carrot juices were obtained, because they can be used by beverage industries for the production of smoothies and/or blended juices for increasing the health-promoting characteristics of liquid products. Moreover, for creating the most preferable taste, the orange carrot variety were the most interesting.

Paragraph 4.4. (Publication 4) investigated fruit-carrot-based smoothies as innovative products with a complex matrix of bioactive compounds able to effect on *in vitro* activities of selected digestive enzymes and cholinesterases. The results showed that the sour cherry juice–purple carrot smoothie had the highest total phenolic acid, anthocyanin and polymeric procyanidin contents. The raspberry juice–purple carrot smoothie showed the highest activities against lipase and butyrylcholinesterase enzyme inhibitions.

Paragraph 4.5. (Publication 5) was focused on the effect of combined drying process in fruit juices (osmotic dehydration, convective drying and microwave vacuum drying) on nutritional, phytochemical, and sensory profiles, and biological activities of coloured dried carrot snakes. Results showed that highest phenolic acid, anthocyanin, flavan-3-ol, polymeric procyanidin and flavonol contents were determined in samples dehydrated with sour cherry and chokeberry solutions. Moreover, the applied process provided novel and sensorily acceptable functional dried carrot snacks.

### ***Overall scientific merit***

The findings of this thesis are interesting, novel and of great technological relevance, adding evidences to the possibility of using different carrot varieties for the development of innovative food products. In the specific, the developed carrot juices, carrot-based smoothies, and dried carrot snacks show health-promoting activities for human diet. Overall, this PhD thesis represents a complete and very good work with many novel results.





**Overall evaluation**

The doctoral dissertation meets the conditions set out in art. 187 ust. 1-4 ustawy z dnia 20 lipca 2018 r. Prawo o szkolnictwie wyższym i nauce (Dz. U. z 2023, poz. 742), and the candidate can be admitted to the final public defence.

Moreover, as the PhD candidate published 5 papers in Q1/Q2 journals as first name and, taking into account the contribution in developing the research from creating the project plan to publishing the papers, the dissertation is outstanding and I request for the distinction.

**Specific comments and suggestions**

The suggestions to the student that can improve her thesis is related to checking some minor typos and mistakes. They have been signed in the pdf copy of the thesis sent by post with the original documents and by email to [anna.krzyńska@upwr.edu.pl](mailto:anna.krzyńska@upwr.edu.pl).

Monserrato, 03/08/2023



Prof. Carlo I.G. Tuberoso