**Development of high-value-oil-based systems through innovative structuring agents and different homogenization techniques for the nutritional and/or functional enhancement of food and non-food matrices**

Marco Panzanini (marco.panzanini1@unicatt.it)

DiSTAS – Department for Sustainable Food Process, Università Cattolica del Sacro Cuore, Piacenza, Italy

Tutor: Prof. Roberta Dordoni

As first activity of the PhD thesis project, different tree nuts were cold pressed to evaluate the effect of oil extraction on the nutritional properties of derived products and by-products. Different varieties of pistachios, hazelnuts, and apricot kernels were characterized for moisture, ash, protein, fat, tocopherols, and color. They were extracted by hydraulic press giving an oil rich in tocopherols and a defatted cake with high nutrient and functional potential: the cake preserved significant fat, vitamin E, protein, and fiber levels based on the oil extraction yield. Innovative applications of defatted cakes as structuring agent will be investigated.

**Sviluppo di sistemi lipidici ad alto valore attraverso l’impiego di agenti strutturanti innovativi e diverse tecniche di omogeneizzazione per il potenziamento nutrizionale e/o funzionale di matrici alimentari e non alimentari**

Come prima attività del progetto di dottorato, diversi frutti a guscio sono stati spremuti a freddo per valutare le proprietà nutrizionali dei prodotti e sottoprodotti derivati. Diverse varietà di pistacchi, nocciole e armelline sono state caratterizzate per umidità, ceneri, proteine, grassi, tocoferoli e colore. La pressatura ha originato un olio ricco di tocoferoli e un panello ad alto valore nutrizionale e funzionale. Il panello ha conservato una preziosa quantità di grassi e vitamina E, con un incremento proporzionale di proteine e fibre in base alla resa di estrazione dell'olio. Saranno studiate applicazioni innovative per utilizzare il panello come agente strutturante.

**Key words**: Tree nuts, oil cold extraction, defatted cake, tocopherols.

# **1. Introduction**

This poster describes the main results of the first activity regarding:

(A1) Select nutritional- and bioactive-rich raw materials;

focus on tree nuts matrices, oils, and defatted cake (DFC) from cold pressing processes, in order to enhance their techno-functional properties and nutritional value.

The next objectives will be:

(A2) Set up greener, milder, and clean label-friendly processes;

formulation of different ingredients and semi-finished products based on fiber-based emulsions suitable for elderly and diabetics.

(A3) Produce high value- oil- based systems (source of proteins, PUFA, tocopherols, and dietary fiber);

evaluation of stability (physicochemical, thermal, rheological, and tribological properties) and food applications.

**2. Materials and Methods**

Five different three nut kernels (BASE) with the corresponding oils and defatted cake (DFC) were kindly provided by Pariani S.r.l. (Givoletto, Torino, Italy). In detail, samples from two types of hazelnuts (mix of Turkish varieties and Piemonte P.G.I.), two types of pistachios (mix of pistachios varieties from Sicily and Bronte P.O.D.), and a mix of apricot kernels varieties from Turkey were supplied. Pariani’s extraction parameters were previously optimized for obtaining the maximum organoleptic evaluation in both DFCs and oils: different kernels were roasted and pressed under different pressure and time allowing to separate oils and DFCs. BASEs and DFCs were preliminary milled and then analysed for colour and moisture, ash, fat, protein, soluble and insoluble dietary fibre, and tocopherols content (Dordoni et al. 2019).

# **3. Results and Discussion**

## **3.1 Defatted cake characterization**

Apricot kernel DFC showed the highest protein concentration 47.63±0.50 due to 79.3% removal of oil. Piedmont P.G.I. hazelnut kernels had the lowest protein content (13.55±0.41% on a d.m. basis) that increased to 38.12±1.42% in DFC, thanks to the highest oil extraction yield 85.6%. In general, the differences in nutritional value between BASE and DFC were primarily due to the redistribution of percentages after the extraction process. Even though the BASEs showed higher protein content on a dry matter basis (26.42±0.21%; 26.93±0.61%), Sicilian and Bronte pistachios had the lowest concentrations among the DFCs. This can be attributed to their lower extraction yields of 50.2% and 38.4%, respectively. Apricot kernels BASE showed a significantly higher moisture content (3.93±0.07%) than other nuts, as they were the only sample that was not roasted but only dried.

The roasting and drying processes generated a decrease in water activity (aw) bringing all the values to be lower than 0.55. The aW had a trend that reflected the humidity: the lowest value was Piemonte I.G.P. (0.30±0.01% and 0.40±0.02 for BASE and DFC samples, respectively) and the highest one was for apricot kernel (0.55±0.00 was observed for both the BASE and DFC samples,). From a microbiological point of view, these values represent a safety limit for the growth of bacteria, molds, and yeasts that are unable to duplicate in such conditions (Grant 2004).

## **3.2 Tocopherol analysis**

The tocopherols homologues resulting as the most abundant in the oil and in the lipid fraction of the DFCs were the same which also appeared to be predominant within the BASEs (Table 1). The DFCs of Piedmont and Turkey hazelnuts showed the highest values of α-tocopherol equivalents (α-TE) denoting the best biological activity as antioxidant. DFCs of apricot kernel and Bronte pistachio contained γ-tocopherol values higher than the matrix. The changes in tocopherol concentration and the apparent increase in their total amount (considering DFC and oil contents relative to BASE samples) could be explained as improved extractability due to the pressure effect. Similar results were reported by Ojeda et al. (2018) describing an increase in the concentration of the α-homologue in partially defatted flours, while γ-tocopherol showed a less constant trend.

Alfa-tocopherol resulted to be heat resistant: in particular, Amaral et al. (2006) demonstrated that its concentration remains high even in the Piedmont hazelnut samples subjected to a long roasting treatment at high temperatures. It should be considered that the roasting process is essential to increase aromas, friability, and extraction yield. A screw press allows to extract the oil and simultaneously to heat the sample by developing a toasted flavour, while a hydraulic press requires to roast the product before processing as there is no heat involved in the process. However, by separating the two phases it is possible to ensure greater control over the process and the derived products. DFCs will undergo an evaluation of their functional properties as part of the process of formulating new products.

***Table 1:*** *α-, γ-, β-, δ-tocopherol content (mg/100g of oil) and α-tocopherol equivalents (α-TE) determined on oil, defatted cakes (DFC), and kernels (BASE). Within each column, different letters indicate statistically different values according to post-hoc comparison (Tukey's test) at p ≤ 0.05. Values are expressed as mean ± sd (n = 6).*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Samples | Tocopherols (mg/100g of oil) | | | | |
|  | **α** | **γ** | **β** | **δ** | **α-TE** |
| Piemonte P.G.I. hazelnut oil | 31.75±2.72e | n.d. | n.d. | n.d. | 21.75 |
| Piemonte P.G.I. hazelnut DFC | 32.74±1.03e | n.d. | n.d. | n.d. | 32.74 |
| Piemonte P.G.I. hazelnut BASE | 21.75±2.65cd | n.d. | n.d. | n.d. | 31.75 |
| Turkish hazelnut oil | 19.95±0.97d | 3.03±0.07a | n.d. | n.d. | 21.53 |
| Turkish hazelnut DFC | 25.34±3.07d | 5.19±0.09a | n.d. | n.d. | 25.86 |
| Turkish hazelnut BASE | 21.00±0.05c | 5.30±0.01a | n.d. | n.d. | 20.25 |
| Apricot kernel oil | 0.27±0.00a | 19.80±0.11b | n.d. | 1.45±0.03a | 3.38 |
| Apricot kernel DFC | 0.42±0.02a | 30.94±2.17c | n.d. | 2.81±0.01b | 3.60 |
| Apricot kernel BASE | 0.35±0.02a | 29.38±2.16cd | n.d. | 3.05±0.18c | 2.30 |
| Sicilian pistachio oil | 1.20±0.02c | 22.80±0.02 c | n.d. | 1.86±0.04b | 6.93 |
| Sicilian pistachio DFC | 0.88±0.04b | 19.85±0.20b | 4.35±0.27a | 1.42±0.06a | 5.08 |
| Sicilian pistachio BASE | 1.00±0.01b | 25.51±0.82b | 6.66±0.07b | 1.54±0.02b | 3.54 |
| Bronte P.O.D. pistachio oil | 0.86±0.003b | 25.66±0.51d | 5.39±0.04 | 1.49±0.03a | 6.13 |
| Bronte P.O.D. pistachio DFC | 1.52±0.04c | 39.53±1.86d | 12.46±0.04b | 3.97±0.02c | 11.82 |
| Bronte P.O.D. pistachio BASE | 1.08±0.78b | 28.38±0.36c | 4.35±1.46a | 1.46±0.01a | 6.16 |

# **4. References**

Dordoni R., Cantaboni S., Spigno G. (2019). “Walnut paste: oxidative stability and effect of grape skin extract addition”. Heliyon (5), e02506. ISSN: 2405-8440.

Grant W.D. (2004) Life at Low Water Activity. Philos Trans R Soc Lond B Biol Sci, 359, 1249–1267.

Ojeda-Amador, R.M.; Salvador, M.D.; Gómez-Alonso, S.; Fregapane, G. (2018) Characterization of Virgin Walnut Oils and Their Residual Cakes Produced from Different Varieties. Food Research International, 108, 396–404.

Amaral, J.S.; Casal, S.; Seabra, R.M.; Oliveira, B.P.P. (2006) Effects of Roasting on Hazelnut Lipids. J Agric Food Chem, 54, 1315–1321.