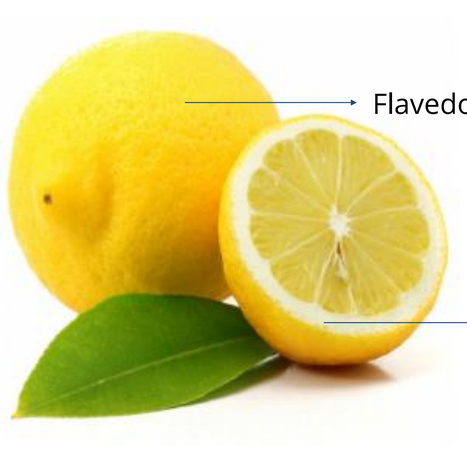
Valorization of *Citrus limon* peels: nutritional and antioxidant approach

Magalhães D[1], Vilas Boas A[1], Teixeira P[1], Pintado M[1,*]

[1]Universidade Católica Portuguesa, CBQF – Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia, Rua Diogo Botelho 1327, 4169-005 Porto, Portugal
*Corresponding author: mpintado@ucp.pt

Introduction



- Flavedo
  - Flavonoids
  - Phenolic Acids
  - Carotenoids
  - Essential oils (EOs)
- Albedo
  - **Dietary fibers:**
  - Soluble: Pectin
  - Insoluble: cellulose, hemicellulose and lignin

Citrus is the most abundant crop of fruit trees in the world, with an annual production of approximately 124.2 million tons. Among the different types of citrus, lemons and limes represent 15.9 million tons [1]. Processing of citrus fruits results in a significant amount of waste (peels, pulps and seeds), which represent about 50% of the raw processed fruits, and are a potential source of valuable co-products. Structurally, lemon peels consist of the outer layer, called flavedo and the inner layer, called albedo. The flavedo contains high amounts of polyphenolic compounds, carotenoids and essential oils, whereas the albedo is rich in dietary fibers, particularly pectin, which grant them nutritional value and health benefits with antioxidant properties [2,3]. So, valorization of those by-products increases the potential return, while at the same time helps preserving the environment.

Objectives

The aim of this work was the characterization of lemon peels in terms of nutritional composition, phenolic compounds identification and quantification and their antioxidant activity

Methods

- **Extraction**

6 g lemon peel →  **40 mL MeOH:H2O (8:2)** →  **Ultra-turrax 18 000 rpm 60 seg** →  **Ultrasonic bath (60 min)** →  **Orbital shaker (16 h)** →  **10 000 rpm, 4 ºC, 10 min** →  **Pellet**;  **Supernatant**

- **Analysis**

 **Phenolics profile (HPLC-DAD)** ← **Total phenolic content (Folin-Ciocalteu)** ← **Antioxidant activity: DPPH and ABTS assay**

Results

1. Nutritional composition

Table 1. Lemon peels by-product nutritional characterization.

COMPONENT	RESULTS
MOISTURE (%W/W)	82.71 ± 0.19
EXPRESSED IN DRY BASIS (%W/W)	
ASH	4.38 ± 0.02
PROTEIN	5.35 ± 0.08
LIPIDS	1.04 ± 0.07
CARBOHYDRATES	89.23*
TOTAL DIETARY FIBER	41.16**
Results are expressed in % dry matter basis (g/100g DM) *Total carbohydrates content obtained by difference.**Only two analytical replicas.	

2. Total phenolic content and antioxidant activity

Table 2. Antioxidant capacity (ABTS and DPPH assay), and total phenolics (Folin-Ciocalteu), for lemon peels.

PARAMETER	CONCENTRATION
Folin-Ciocalteu (mg GAE/G FW)	2.30 ± 0.26
ABTS Assay (mg AAE/G FW)	2.33 ± 0.08
DPPH Assay (mg TE/G FW)	0.85 ± 0.10
Abb.: gallic acid equivalent, GAE; Ascorbic acid equivalent, AAE; Trolox equivalent, TE; Fresh weight, FW.	

3. Phenolic compounds identification and quantification: eriocitrin and hesperidin

Table 3. Quantification of phenolic compounds (eriocitrin and hesperidin) in lemon peels

PARAMETER	CONCENTRATION
Eriocitrin (mg/g FW)	1.39 ± 0.02
Hesperidin (mg/g FW)	0.57 ± 0.02
Fresh weight, FW.	

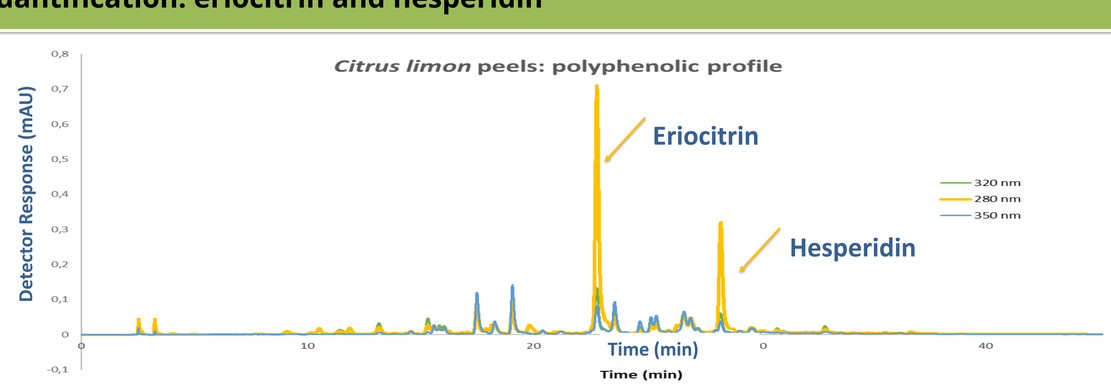


Figure 1. Chromatographic profile of phenolic compounds in lemon peels, obtained with HPLC-DAD (280 / 350 nm).

Discussion and Conclusions

✓ Table 1 shows the nutritional composition of lemon peels. The results show a high and main concentration of carbohydrates (89.23 g/100g DM) including a relevant content of dietary fiber (41.16 g/100 g DM). Table 2 shows the total phenolic compounds and the antioxidant activity (ABTS and DPPH assay) of lemon peels. A polyphenol content of 2.30 mg GAE/g was observed together with good scavenging effects on DPPH and ABTS radicals, representing 0.85 mg AAE/g and 2.33 mg TE/g. Table 3 shows the eriocitrin and hesperidin quantification at concentrations of 1.39 mg/g FW and 0.57 mg/g FW, respectively. According to these results, it can be concluded that lemon peels by-products, contain interesting compounds (mainly dietary fiber and phenolic compounds). Their concentrations are significant justifying their valorization in different food applications contributing for a circular economy and sustainable perspectives.

References

[1] FAO (2017). Statistical Bulletin 2016. Trade and Markets Division, 47.
[2] Kim, S.Y. (2018). Preventive Nutrition and Food Science, 23 (4), 335–340.
[3] Klimek-szczykutowicz, M. et.al. (2020). Plants, 9 (1).

Acknowledgements

The authors would like to thank MEDISMART project (reference PRIMA/0014/2019) support and the scientific collaboration of CBQF under the FCT project. The author Daniela Magalhães would like to acknowledge the individual grant. This work was financially supported by national funds through FCT – Fundação para a Ciência e a Tecnologia within the MEDISMART project (reference PRIMA/0014/2019).