

## Enhanced quality of pistachio kernel and skin obtained using liquid nitrogen as peeling agent

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The first activity of the PhD project is described. Two pistachio cultivars (*Pistacia vera* L.) were subjected to traditional peeling (P-H<sub>2</sub>O), using hot water and an experimental peeling (P-LN<sub>2</sub>), using liquid nitrogen. The following physico-chemical characteristics were evaluated on pistachio kernel: moisture, water activity, peroxide number, total acidity and colorimetric parameters. Moreover, the obtained skin were even characterized for: total polyphenols content, anthocyanins, flavonoids and antioxidant activity.

### Miglioramento della qualità di pistacchio e skin ottenuti usando azoto liquido come agente di pelatura

La prima attività del progetto di dottorato è stata descritta. Due cultivar di pistacchio (*Pistacia vera* L.) sono state soggette a pelatura tradizionale, usando acqua calda (H<sub>2</sub>O), e pelatura sperimentale, usando azoto liquido (LN<sub>2</sub>). Sono state valutate le seguenti caratteristiche fisico-chimiche sui pistacchi pelati: umidità, attività dell'acqua, numero di perossidi, acidità totale e parametri colorimetrici. Sono state inoltre effettuate le seguenti analisi sulle skin: contenuto di polifenoli totali, antociani, flavonoidi e attività antiossidante

**Key words:** Pistachio Peeling, Liquid Nitrogen, Peroxide Value, Bioactive Compounds, Antioxidant Activity.

### 1. Introduction

In accordance with the PhD project, this poster reports the main results of the first activity concerning:

- The determination of physico-chemical characteristics such as moisture (M%), water activity (Aw), peroxide value (PV), total acidity (TA) and colorimetric parameters of two pistachio cultivars subjected to different peeling methods;
- The determination of bioactive compounds such as total polyphenol content (TPC), flavonoids (TFC), anthocyanins and antioxidant activity (DPPH and FRAP) of pistachio skin obtained from different peeling treatments.

### 2. Materials and Methods

#### 2.1 Samples Preparation

Two cultivars of unpeeled pistachio, respectively from Spain and Bronte (Italy) were used for the analysis above described. Traditional peeling (P-H<sub>2</sub>O) was done as reported by Shakerardekani & Mohamadi (2019). After an immersion in hot water (95°C±1°C for 2 min') kernel and skin were manually peeled and left to dry at 70°C for 2 h. Experimental peeling (P-LN<sub>2</sub>) was carried out by exposing pistachio seeds to the LN<sub>2</sub> for 20 minutes and manually peeled.

#### 2.2 Kernel and skin Analysis

Regarding the physico-chemical characteristics of kernels, M (%) was evaluated at 105°C until constant weight with an electronic moisture balance, while Aw was analysed using a hygrometric method. PV (meqO<sub>2</sub>/kg of oil) and TA (%) were analysed following the standard method reported by Commission Regulation N° 2568/91 – EEC 1991. Color of P-H<sub>2</sub>O and P-LN<sub>2</sub> kernels were valued with a portable colorimeter Konica Minolta CM-2500d (illuminant D65). Regarding pistachio skin obtained from P-H<sub>2</sub>O and P-LN<sub>2</sub>, their bioactive compounds were evaluated from an extract prepared following Parafati et al. (2020). TPC (mgGAE/g of skin) was analysed using the Folin-Ciocalteu assay (Singleton et al., 1999). TFC (mgQUE/g of skin) were evaluated using the method conducted by Lin & Tang (2007). Anthocyanins content (mgCy-GE/g of skin) was carried out following the method reported by Rapisarda et al. (1999). The antioxidant activity was analysed using DPPH (2,2-diphenyl-1-picrylhydrazyl) assay reported by Brand-Williams et al. (1995) and FRAP (Ferric Reducing Antioxidant Power) assay reported by Perna et al. (2014) and both expressed as mgTE/g of skin. Each analysis was performed in triplicate, and data obtained were statistically analysed using the software Minitab™ (version 20.0). One-way analysis of variance (ANOVA) was performed on mean values and Fisher's test was conducted to compare the difference between P-H<sub>2</sub>O and P-LN<sub>2</sub> (differences between sample means were considered significant at p ≤ 0.05).

### 3. Results and Discussion

#### 3.1 Physico-chemical characteristics of kernels

Results of physico-chemical parameters of pistachio kernel obtained from P-H<sub>2</sub>O and P-LN<sub>2</sub> are showed in Table 1. According to official pistachio quality control standards, the acceptable moisture value of peeled pistachio is approximately 6-9% (UNECE Standard DDP-10, 2010). Low humidity and Aw values are essential to stabilize the product during storage and to prevent contamination. The peeling with LN<sub>2</sub> could prevent from lipid oxidation phenomena, as demonstrated by PV, much lower in kernels obtained from P-LN<sub>2</sub>. Moreover, color data showed significant (p < 0.05) differences in pistachio peeled with different methods (Tab. 1); in particular, kernels obtained from P-LN<sub>2</sub> evidenced a higher L\* parameter in both pistachio samples. Pistachio kernel obtained from P-LN<sub>2</sub> could influence the quality of the final product, improving its characteristics and stability.

**Table 2.** Bioactive compounds and antioxidant activity of pistachio skin obtained from P-H<sub>2</sub>O and P-LN<sub>2</sub>.

	Bronte		Spain	
	P-H <sub>2</sub> O	P-LN <sub>2</sub>	P-H <sub>2</sub> O	P-LN <sub>2</sub>
TPC	13.33±2.56b	69.84±8.15a	13.11±3.67b	53.46±6.55a
TFC	0.92±0.02b	3.14±0.12a	0.52±0.06b	2.95±0.06a
Anthocyanins	24.75±4.04b	406.65±39.96a	22.48±2.09b	429.87±61.98a
DPPH	20.69±1.10b	122.30±0.64a	27.87±3.03b	70.74±3.59a
FRAP	20.41±0.74b	197.60±3.83a	33.67±2.91b	111.80±2.86a

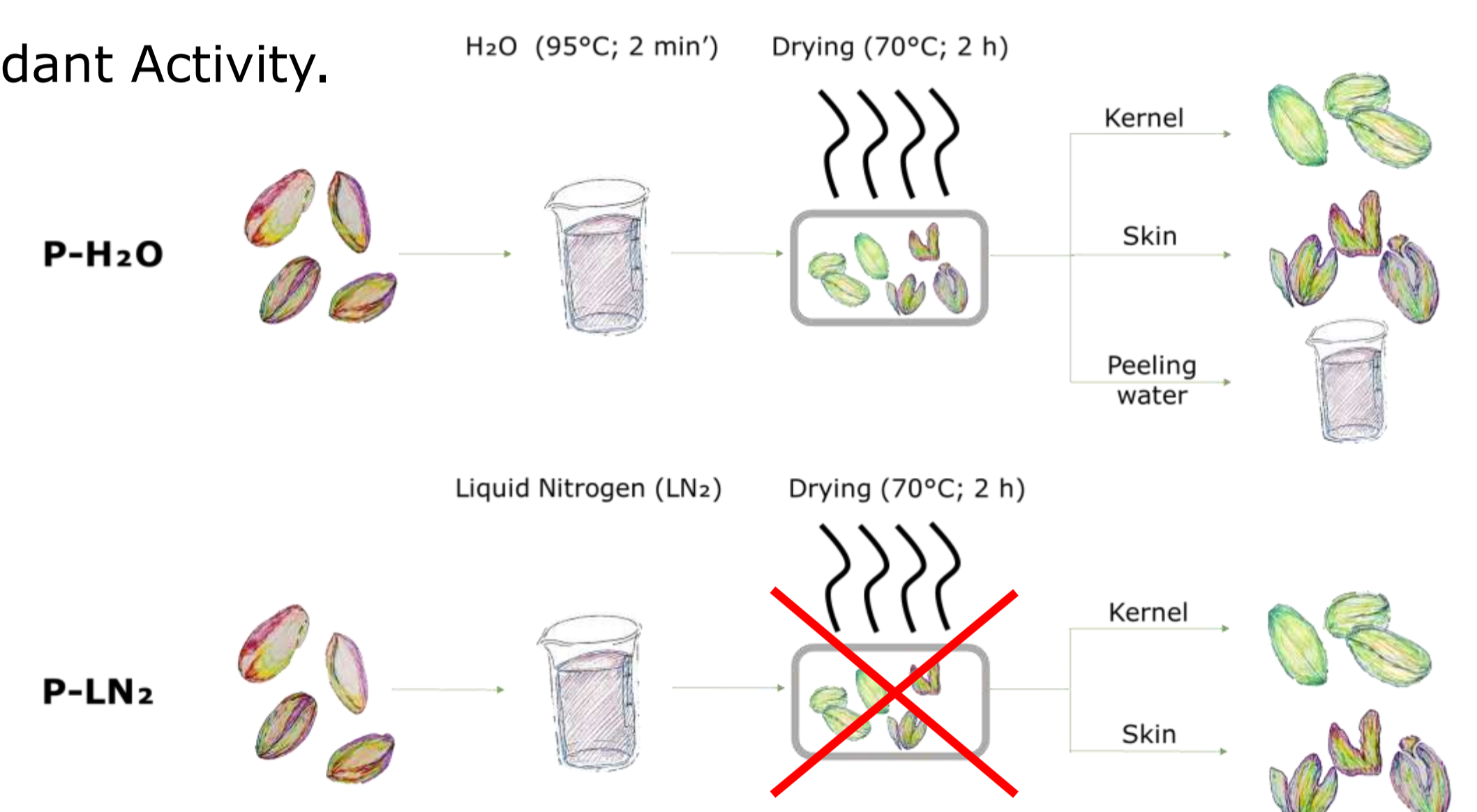
Data are express as mean value±standard deviation. Values followed by different letter are significantly different according to Fisher's least significant difference test (p < 0.05).

### 4. Conclusions

Liquid nitrogen was used as alternative agent to peel pistachio nuts. Through this method it is possible to obtain a peeled product with a lower peroxide value and better colorimetric parameters, reducing water consumption and environmental impact. Moreover, the obtained skin, rich in bioactive compounds with a high antioxidant activity, could be employed as functional ingredient in many formulations.

### References

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**Table 1.** Physico-chemical parameters of pistachio kernel obtained from P-H<sub>2</sub>O and P-LN<sub>2</sub>.

	Bronte				Spain				
	Unpeeled	P-H <sub>2</sub> O before drying	P-H <sub>2</sub> O after drying	P-LN <sub>2</sub>	Unpeeled	P-H <sub>2</sub> O before drying	P-H <sub>2</sub> O after drying	P-LN <sub>2</sub>	
<b>M</b>	3.26±0.24c	35.18±0.35a	6.95±1.38b	2.07±0.20c	<b>M</b>	2.66±0.70b	22.32±1.10a	3.11±0.98b	1.52±0.44b
<b>Aw</b>	0.51±0.02c	0.90±0.01a	0.61±0.07b	0.54±0.02bc	<b>Aw</b>	0.46±0.00c	0.90±0.00a	0.49±0.02c	0.53±0.02b
<b>PV</b>	7.33±0.36b	-	26.41±0.05a	6.64±0.47b	<b>PV</b>	6.16±0.05b	-	12.93±1.07a	5.83±0.81b
<b>TA</b>	2.10±0.20c	-	3.13±0.50b	9.03±0.60a	<b>TA</b>	1.40±0.01b	-	2.09±0.63b	10.18±0.49a
<b>L*</b>	-	-	20.27±4.90b	29.52±3.34a	<b>L*</b>	-	-	23.67±1.27b	43.88±2.47a
<b>a*</b>	-	-	-15.56±1.83a	-14.10±0.67a	<b>a*</b>	-	-	-5.27±1.33b	-3.27±0.91a
<b>b*</b>	-	-	26.78±5.15b	32.67±1.84a	<b>b*</b>	-	-	28.95±2.38b	44.28±2.61a
<b>C*</b>	-	-	31.17±3.75b	35.59±1.70a	<b>C*</b>	-	-	29.46±2.26b	44.40±2.60a
<b>h°</b>	-	-	120.83±6.90a	113.39±1.60b	<b>h°</b>	-	-	94.23±1.61b	100.39±3.02a

Data are express as mean value±standard deviation. Values followed by different letter are significantly different according to Fisher's least significant difference test (p < 0.05).

#### 3.2 Bioactive compounds and antioxidant activity of pistachio skin

Results of bioactive compounds and antioxidant activity of pistachio skin obtained from P-H<sub>2</sub>O and P-LN<sub>2</sub> are showed in Table 2. In particular, it is possible to observe how pistachio skins obtained from P-LN<sub>2</sub> have values significantly (p < 0.05) higher than those obtained from P-H<sub>2</sub>O. In particular, anthocyanin content shows values about twenty times higher in both pistachio skins obtained from P-LN<sub>2</sub>. These results evidence how P-LN<sub>2</sub> could be an effective treatment capable to preserving skin bioactive compounds with a high antioxidant power.