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Valuing endogenous and thermal resources in the production of healthy food: chestnut by-product flour with thermal water

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INTRODUCTION

There is a gap between food, nutrition and public health policies and the population's economic capacity to practice healthy eating. It is imperative to invest in food sustainability that guarantees access to nutritious and safe food.

Endogenous resources and thermal waters are two aspects that promote regional tourism in Trás-os-Montes, Portugal and Galicia, in northern Spain.

THE AIM OF THE STUDY

Contribution of the incorporation of thermal waters into the sustainable production of chestnut flour with chestnut by-products:

Test the feasibility of using chestnut by-products, shells, and hedgehogs in flour production.

Evaluate the chemical and nutritional contribution of incorporating thermal water in the production of chestnut flour.

Valuing endogenous gastronomy by using thermal chestnut flour in culinary recipes.

METHODOLOGY

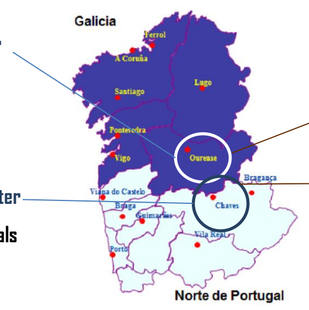
RAW MATERIAL LOCALIZATION Chestnut by-products and thermal waters from Portugal and Spain

Ourense Thermal Water

Silicate, lithic and fluoride waters, presence of bicarbonates. Temperature: 19 - 67°C

Chaves Thermal Water

Gasocarbonic, **bicarbonated and rich in minerals** (sodium, silica, fluoruro). Temperature 76 °C



***Castanea sativa* Miller**

Galician and Portuguese Chestnut-Variety longal

CREATING FORMULATIONS BY DIFFERENT PROCESSES

Summary Table 1- Preparation of samples of chestnuts, shells and sea hedgehogs with water

Chestnut	Chestnut shells	Chestnut hedgehog
Dry chestnut	Dry chestnut shells	Fresh chestnut hedgehog
Roasted chestnut	Roasted chestnut shells	
Cooked chestnut with drinking water	Cooked chestnut shells with drinking water	
Cooked chestnut with thermal water	Cooked chestnut with Thermal Water	

Remarks: repeat the process for chestnuts from Trás-os-Montes and Galicia chestnuts and thermal water from Chaves and Ourense.

CHESTNUT FLOUR PROCESSING

- Add hedgehogs to each shell sample
- Grind the formulated samples
- Chemical characterization of the sample extracts

Preparation shells and hedgehogs samples for extraction

Optimal formulation of raw materials

- Chestnut formulations
- Extracts of chestnut shells and hedgehogs

- Chemical and nutritional characterisation
- Organoleptic characteristics
- Microbiological analyses

Best thermal chestnut flour formulation

DATA REVIEW - Different processing effects manufacturing procedures for chestnut flour

CASE I : Type of thermal process: roasting and boiling

CASE II: Cooking time: 10 min.; 30min.;50 min.

RESULTS & DISCUSSION

DATA REVIEW - Different manufacturing procedures for chestnut flour

CASE I: Type of thermal process: roasting and boiling

Roasted chestnuts possessed higher protein, fiber, citric acid, gallic acid, and total phenolic contents while boiled chestnuts had higher fat, soluble fiber, gallic and ellagic acids, and total phenolic contents when compared to raw chestnuts.

CASE II: Cooking time: 10 min.; 30 min.; 50 min.

In this study, it was found that protein content decreases as the cooking time increases. As for fiber, CC flours (raw chestnut) and CZ3 flours (cooked chestnut-10 min) were those that presented the highest values. The fat content decreases as the cooking time increases, fifty minutes, in which case the flour acquires a rancid odor.

Variable: **Type of thermal process** **CASE I**

Table 1. Primary and secondary metabolite composition of raw, boiled, and roasted chestnuts. Means (n = 33) ± standard deviations followed by the same letter within a line are not significantly different at p < 0.05. (adapted from [1])

Parameters	Raw	Boiled	Roasted
Dry mass (g/100g edible)	46,8 ± 2,88	42,1 ± 2,60	54,2 ± 3,46
Ash (g/100g DW)	2,06 ± 0,29	1,75 ± 0,23	**2,11 ± 0,29**
Protein (g/100g DW)	6,51 ± 1,38	6,28 ± 1,12	**6,72 ± 1,21**
Fat (g/100g DW)	3,20 ± 0,75	3,33 ± 1,07	**3,08 ± 0,56**
Insoluble fibre (g/100g DW)	13,9 ± 2,41	14,1 ± 2,16	20,0 ± 3,21
Soluble fibre (g/100g DW)	1,06 ± 0,36	1,66 ± 0,63	1,65 ± 0,72
Total fibre (g/100g DW)	13,7 ± 2,21	**15,4 ± 1,70**	**20,1 ± 2,99**
Citric acid (mg/100g DW)	396 ± 259	**592 ± 292**	**634 ± 175**
Malic acid (mg/100g DW)	322 ± 101	123 ± 137	253 ± 152
Gallic acid (mg/kg DW)	10,9 ± 5,81	**13,6 ± 3,02**	**13,7 ± 6,23**
Ellagic acid (mg/kg DW)	6,32 ± 7,06	**12,2 ± 5,61**	8,62 ± 4,97
Total phenolics (mg/g DW)	16,2 ± 2,10	16,5 ± 2,77	**19,3 ± 2,57**

Variable: **Cooking time** **CASE II**

Table 2. Results of the compositional analyses carried out on the flours obtained, expressed on a wet and dry basis . (adapted from [2])

Parameters (%)	Chestnut by-products flour samples								Reference values dried chestnuts (INSA, 2016)
	Raw chestnut (CC)		Cooked Chestnut (CZ1-30 min)		Cooked Chestnut (CZ2-50 min)		Cooked Chestnut (CZ3-10 min)		
	humid base	dry base	humid base	dry base	humid base	dry base	humid base	dry base	humid base
Moisture	7,13 ± 0,06	-	6,95 ± 0,15	-	**0,48 ± 0,11**	-	6,42 ± 0,13	-	9.90
Dry extract	-	92,87 ± 0,06	-	93,05 ± 0,15	-	99,52 ± 0,11	-	93,58 ± 0,13	90,1
Protein	**4,92 ± 0,01**	**5,29 ± 0,02**	3,60 ± 0,05	3,86 ± 0,05	3,62 ± 0,05	3,64 ± 0,05	3,80 ± 0,08	4,06 ± 0,08	5,10
Fibre	10,00*	10,77*	8,56*	9,20*	9,04 ± 0,99	9,08 ±0,99	**10,20 ± 1,25**	**10,90 ± 1,33**	11,30
Ash	1,55 ± 0,02	1,67 ± 0,02	**2,88 ± 0,03**	**3,09 ± 0,04**	1,11 ± 1,11	1,12 ± 0,02	1,22 ± 0,02	1,30 ± 0,02	2,10
Lipid	2,28 ± 0,12	2,46 ± 0,12	2,76 ± 0,2	2,97 ± 0,22	**1,30 ± 0,35**	**1,31 ± 0,35**	2,68 ± 0,02	2,86 ± 0,02	2,00
Carbohydrates	74,12 ± 0,08	79,81 ± 0,13	75,26 ± 0,42	80,92 ± 0,29	**84,45 ± 0,81**	**84,87 ± 0,70**	75,77 ± 1,29	80,90 ± 1,24	70,00

CONCLUSION

The cooking processes affected the chemical composition of the chestnut, providing a positive effect in terms of the digestibility of macromolecules such as proteins and fibers. Chestnut flour cooked for 10 minutes has a higher fiber content compared to other cooking times. Cooked chestnuts are a good source of phenolic compounds and organic acids and are low in fat.

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