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EFFECT OF THE ADDITION OF NETTLE LEAF POWDER ON THE QUALITY CHARACTERISTICS OF CRACKERS

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Abstract: The main objective of this study was to investigate the bioactive potential of nettle leaf powder (NLP) by incorporating it into cracker formulations to improve their sensory, nutritional, physical, and phytochemical properties. Wheat flour (WF) was partially replaced with NLP at levels of 2%, 4%, 6%, and 8% (*w/w*). Concurrently, a sample was prepared exclusively from WF (control). Proximate composition analysis revealed that all four cracker formulations enriched with NLP exhibited a superior nutritional profile compared to the control sample. These formulations were characterized by significantly higher contents of proteins, minerals, and dietary fiber, alongside a reduced carbohydrate content. The results of the sensory analysis showed that the crackers sample with a 4% NLF incorporation was the most appreciated by the evaluators. Furthermore, the incorporation of up to 8% NLP into the cracker formulations led to significant increases in total phenolic content (TPC) and antioxidant activity (AA) relative to the control sample. These findings support the use of NLP as a partial substitute for WF in the development of functional crackers, highlighting its potential for the creation of innovative food products with enhanced nutritional and functional value.
Keywords: *nettle leaf powder, functional crackers, sensory evaluation, nutritional profile, antioxidant activity*

• Introduction

The utilization of medicinal plants as functional ingredients in food fortification constitutes a sustainable strategy for the development of innovative food products, hese are rich sources bioactive compounds (e.g., antioxidants, vitamins, phenolic compounds). These bioactive compounds possess the capacity to enhance the nutraceutical qualities and health-promoting benefits of food items. NLF has a high nutritional value, it contains protein, dietary fiber, vitamins (vitamins A, C, K and B), minerals (calcium, iron, magnesium, phosphorus, potassium and sodium), fats (linoleic, linolenic, palmitic, stearic and oleic), amino acids (all essential amino acids), amino acids (all essential amino acids), polyphenols (kaempferol, quercetin, caffeic acid and other flavonoids), pigments (beta-carotene, lutein, luteoxanthin and other carotenoids).

• Material and method

WF, NLP and the other ingredients utilized in this study were procured from local market in Timisoara, Romania.
Standard analytical methods were used to determine the proximate composition, physical and sensory properties, total polyphenol content and total antioxidant capacity of the resulting cracker samples.

• Results and discussion

The replacement of wheat flour (WF) with NLP in cracker formulations resulted in reductions in moisture and carbohydrate content. Conversely, the contents of protein, fiber, minerals, and fat increased significantly in proportion to the level of NLP substitution (Table 1). The physical characteristics of the NLP-supplemented cracker formulations also showed a significant decline compared to the control sample, with this reduction being directly proportional to the degree of WF replacement (Table 2). Additionally, the NLP-enriched cracker formulations exhibited higher total phenolic content (TPC) and antioxidant activity (AA) than the control sample (Table 3). Among them, the C8NLP sample recorded the highest TPC and AA values, highlighting the superior functional properties of NLP.
The cracker formulations obtained are shown in Figure 1:

Figure 1. The assortments of crackers

The sensory evaluation of WF- and NLP-based crackers indicated that incorporating up to 4% NLP in the formulation led to improved consumer acceptance. Collectively, these findings support the potential of NLP as a functional ingredient in the development of healthier cracker alternatives that appeal to health-conscious consumers seeking more nutritious flour products.

Table 1. Proximate composition of cracker samples

Cracker samples	Proximate composition (%)					
	Moisture	Fat	Protein	Fiber	Ash	CRB*
CC	9.84 ± 0.12	11.32 ± 0.24	10.64 ± 0.04	1.36 ± 0.34	1.44 ± 0.02	65.40
C2NLP	8.56 ± 0.04	11.14 ± 0.33	16.06 ± 0.22	2.06 ± 0.18	1.94 ± 0.13	60.24
C4NLP	8.43 ± 0.31	10.97 ± 0.14	16.50 ± 0.34	2.85 ± 0.55	2.49 ± 0.05	58.76
C6NLP	8.32 ± 0.04	10.79 ± 0.09	16.93 ± 0.09	3.22 ± 0.09	2.98 ± 0.05	57.76
C8NLP	8.12 ± 0.04	10.61 ± 0.21	17.36 ± 0.11	3.98 ± 0.13	3.39 ± 0.14	56.4

CC – Control crackers (100% wheat flour (WF): 0% nettle leaf powder (NLP); **C2NLP** - Cracker samples with 98% wheat flour (WF): 2% nettle leaf powder (NLP); **C4NLP** - Cracker samples with 96% wheat flour (WF): 4% nettle leaf powder (NLP); **C6NLP** - Cracker samples with 94% wheat flour (WF): 6% nettle leaf powder (NLP); **C8NLP** - Cracker samples with 92% wheat flour (WF): 8% nettle leaf powder (NLP).

Table 2. Physical properties of cracker samples

Cracker samples	Physical properties			
	Baking loss (%)	Diameter (mm)	Thickness (mm)	Spread ratio
CC	8.74 ± 0.32	36.52±0.07	4.40±0.02	10.32 ± 0.04
C2NLP	8.32 ± 0.25	35.69±0.32	3.82±0.44	10.02 ± 0.35
C4NLP	8.16 ± 0.09	34.22±0.62	3.66±0.08	9.77 ± 0.14
C6NLP	8.04 ± 0.12	33.38±0.43	3.44±0.33	9.49 ± 0.09
C8NLP	7.83 ± 0.44	32.49±0.09	2.22±0.04	9.21 ± 0.22

Table 3. Phytochemical properties of cracker samples

Cracker samples	Phytochemical properties	
	TPC (mg GAE/g)	AA (µmol TE/ g)
CC	89.47±0.06	4.27±0.09
C2NLP	93.40±0.33	5.18±0.35
C4NLP	102.87±0.26	7.35±0.24
C6NLP	114.42±0.05	9.21±0.21
C8NLP	123.52±0.69	12.87±0.03

• Conclusions

The study highlights that the analyzed cracker samples exhibit an improved nutritional profile, characterized by increased levels of protein, fiber, minerals, and fats, along with a reduced carbohydrate content. Sensory evaluation revealed good overall acceptability for crackers enriched with up to 4% nettle leaf powder (NLP), without compromising the sensory quality of the products. Therefore, supplementation with up to 4% NLP can be implemented on an industrial scale in the manufacturing process of crackers without negatively affecting their quality attributes. In this context, the use of NLP as a functional ingredient represents a promising approach for developing flour-based products with enhanced nutritional value, offering valuable prospects for future research.