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Nanocelluloses from agrifood by-products: utilization in ice cream production

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State of the art

Nanocelluloses (NCs) are cellulosic materials with nanometer-scale dimensions, isolated from cellulosic and lignocellulosic sources through enzymatic, chemical, or physical processes or produced by bacteria from glucose. NCs are classified into cellulose nanocrystals (CNCs), cellulose nanofibers (CNFs), and bacterial nanocellulose (BNC). CNCs, derived from acid hydrolysis, are highly crystalline and rigid, while CNFs obtained via mechanical processes, like homogenization, are flexible with both crystalline and amorphous regions (Perumal et al., 2022). NCs find applications in composites, absorbent webs, paper, food products, coatings, cosmetics, and filters (Mokhena and John, 2020). Among others, NCs might be used as thickening agents, emulsifiers, stabilizers, fat replacers, and carriers for bioactive compounds in food (Turbak et al., 1983; Perumal et al., 2022). While stabilizers and emulsifiers improve viscosity, foam stability, and texture in ice cream production, the use of NCs in ice cream has been little investigated. In 2018, Guo et al. found that BNC gels can replace cream and improve texture, while in 2019, Li et al. observed that NCs addition inhibits ice recrystallization. Later on, Velásquez-Cock et al. (2019) showed that CNFs enhance viscosity and slow melting, and more recently, Samsalee et al. (2024) have reported that high CNCs concentrations improve overrun and viscosity in 10% fat ice cream. However, a thorough investigation on NCs use in ice cream is missing.

PhD Thesis Objectives and Milestones

This PhD project aims investigating the potential of NCs as stabilizers and emulsifiers in industrial ice cream production, seeking to replace traditional ingredients with sustainable alternatives, utilizing by-products from the agri-food industry. The project is structured as follows (Table 1):

A1) Literature review to explore relevant developments in ice cream research.
A2) CNCs and CNFs extraction and characterization from various sources using acid hydrolysis and homogenization, assessing their morphological, chemical, rheological, and thermal properties.
A3) Industrial research to characterize traditional products and test NCs as stabilizer/emulsifier substitutes, also evaluating the rheological, structural, and stability properties of the products.
A4) Writing and Editing the PhD thesis, scientific papers, and oral and/or poster communications.

Table 1. Gantt diagram

Activities	Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A1)	***Literature review***																								
A2)	***Extraction and characterization of CNCs and CNFs***																								
	1) NCs extraction																								
	2) NCs characterization																								
A3)	***Industrial research***																								
	1) Technological requirements for ice cream production																								
	2) Production tests																								
A4)	***Thesis & Papers Preparation***																								

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