Microencapsulation of roselle (Hibiscus sabdariffa L.) anthocyanins: Effects of different carriers on selected physicochemical properties and antioxidant activities of spray-dried and freeze-dried powder

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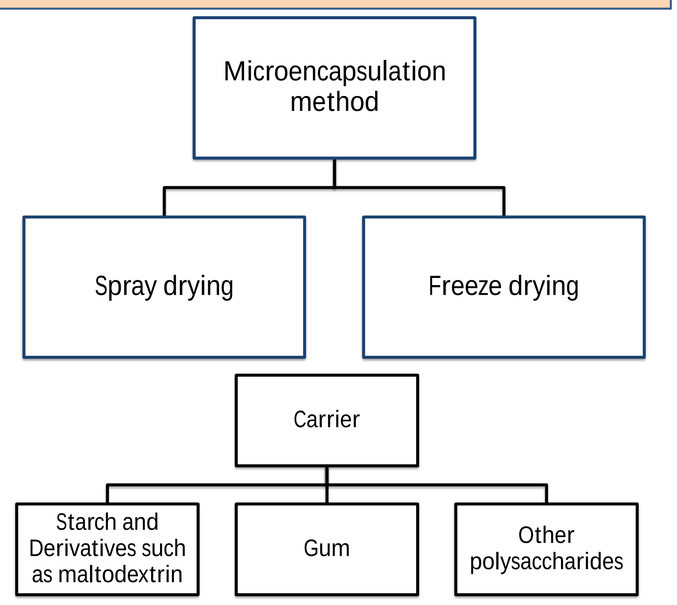
Abstract

Anthocyanins are abundant phytochemicals in nature that draw the public interest not only in their health effects, such as antioxidant, anti-inflammatory and anti-carcinogenic properties. It also showed their function in providing foodstuffs with appealing and distinctive color. In this study, anthocyanins from hibiscus (Hibiscus sabdariffa L.) calyces were microencapsulated by spray drying and freeze drying techniques using a wide variety of carriers including maltodextrin (MD), gum Arabic (GA) and their binary blends with inulin (INU) and konjac glucomannan (KON). The results showed that freeze-dried hibiscus powder using KON as carrier had the highest phenolic, anthocyanin and antioxidant activity, followed by spray-dried and freeze-dried MD/KON samples, which indicated the role of KON in the effective retention of antioxidants during the drying process. In addition, the ferric and cupric ion reduction activity (FRAP and CUPRAC) of the spray- dried samples was significantly higher than those of the freeze-dried powder. However, in terms of encapsulation efficiency (EE) of anthocyanins, KON was shown to be ineffective in entrapping these compounds in microcapsules with the lowest EE of freeze-dried KON and spray-dried MD/KON of 43.6% and 55.4%, respectively. By contrast, MD/GA was the most effective carrier, retaining anthocyanins inside the carrier matrix and limiting their loss to the surface of the microcapsules in both spray-drying and freeze-drying methods (EE of 91.8% and 95.7%, respectively). In addition, the moisture content of spray-dried powder samples was significantly higher than that of lyophilized powders, and the solubility of all samples was above 94.1%. [6]

Introduction

Fig 1. Hibiscus calyces

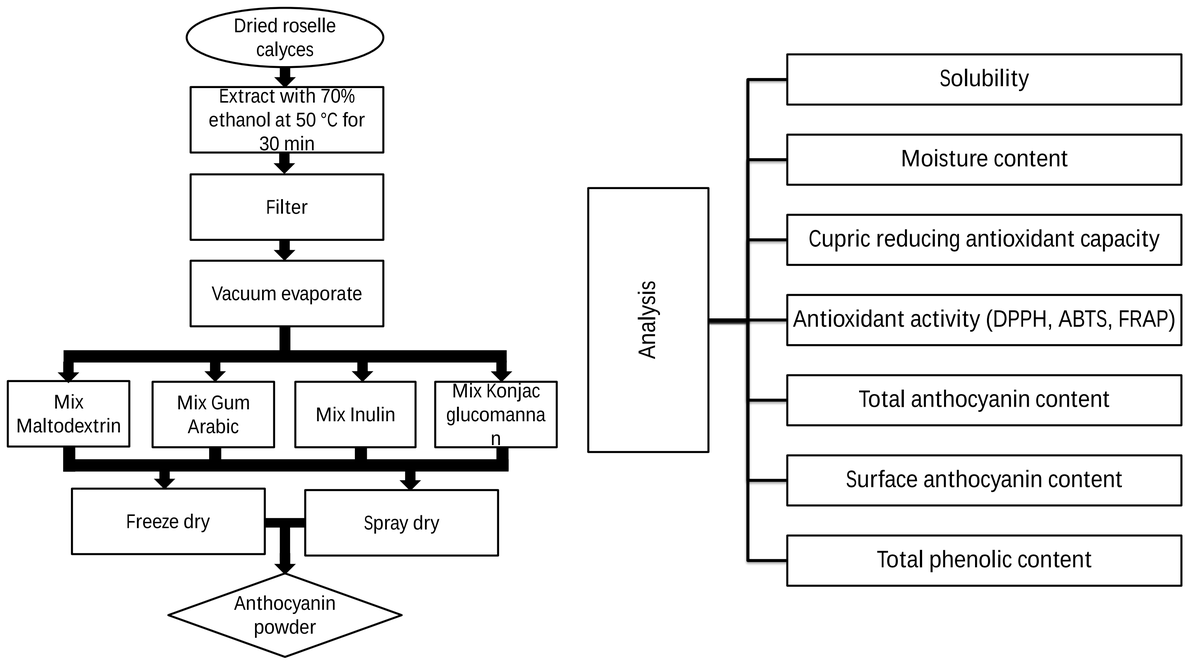
- Rich in dietary fiber
- Polyphenols and antioxidants
- Numerous health Benefits
- Different applications in food and pharmaceuticals



Methods and Materials

Carrier composition	Abbreviation	% MD	% GA	% INU	% KON
#1 Maltodextrin	MD	100	0	0	0
#2 Gum Arabic	GA	0	100	0	0
#3 Maltodextrin + gum Arabic	MD/GA	50	50	0	0
#4 Maltodextrin + inulin	MD/INU	50	0	50	0
#5 Maltodextrin + konjac	MD/KON	50	0	0	50
#6 Konjac	KON	0	0	0	100

Table 1. Composition of different carriers used in the spray drying and freeze drying of roselle anthocyanin extracts.



Results and Discussion

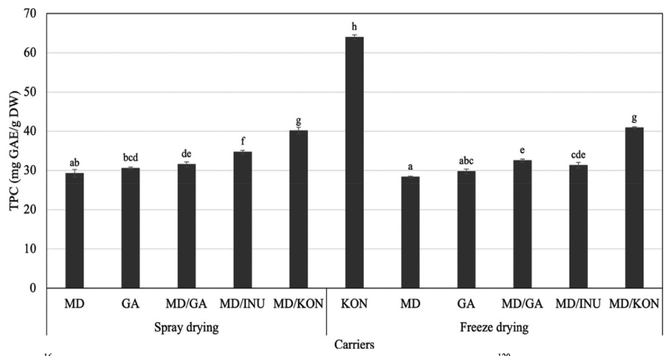


Fig 1. Effects of different carriers on total phenolic content (TPC, mg GAE/g DW) of spray-dried (SD) and freeze-dried (FD) roselle powder. [6]

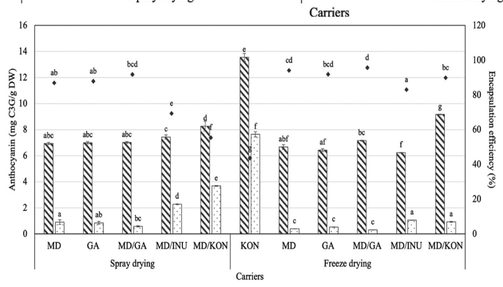


Fig 2. Effects of different carriers on total anthocyanin (TAC, mg C3G/g DW), surface anthocyanin (SAC, mg C3G/g DW) contents and encapsulation efficiency (EE, %) of spray-dried and freeze-dried roselle powder. [6]

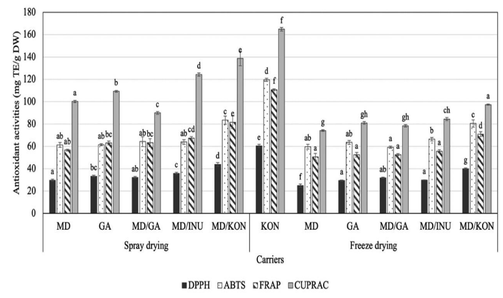


Fig 3. Effects of different carriers on antioxidant activities (mg TE/g DW) of spray-dried and freeze-dried roselle powder including DPPH radical scavenging activity, ABTS cation radical reduction ability, ferric reducing antioxidant power – FRAP, cupric reducing antioxidant capacity – CUPRAC. [6]

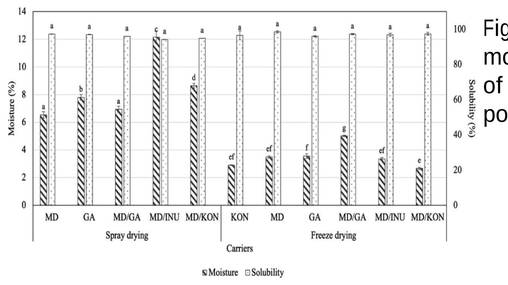


Fig 4. Effects of different carriers on moisture content (%) and solubility (%) of spray-dried and freeze-dried roselle powder. [6]

	TPC	TAC	DPPH	ABTS	FRAP	CUPRAC
TPC	1					
TAC	0.986**	1				
DPPH	0.976**	0.954**	1			
ABTS	0.982**	0.962**	0.962**	1		
FRAP	0.960**	0.942**	0.985**	0.958**	1	
CUPRAC	0.825**	0.799**	0.901**	0.816**	0.930**	1

** Correlation is significant at the 0.01 level (2-tailed).

Table 2. Pearson correlation between the contents of phenolics, anthocyanins and antioxidant activities (DPPH free radical scavenging activity, ABTS cation radical scavenging capacity, ferric reducing antioxidant power – FRAP, and cupric reducing antioxidant capacity – CUPRAC) of spray-dried and freeze-dried roselle powder. [6]

Conclusions

Spray-drying and freeze-drying are two popular and effective methods for microencapsulating phenolic compounds, especially anthocyanins, with the aim of protecting the activity of this group of compounds. When comparing the efficiency between a wide range of carriers, including single carriers and binary blends, the use of a mixture of maltodextrin and gum Arabic as carriers led to the development of spray-dried and freeze-dried powder with relatively high antioxidant content and exceptional encapsulation efficiency (above 90%). Meanwhile, although the use of single konjac glucomannan, a homopolysaccharide, created the best powder with highest antioxidant contents and activities, anthocyanins seemed to be mostly located on the surface of microcapsules, as demonstrated by low encapsulation efficiency. However, this drawback of konjac glucomannan can be overcome by using different coatings to limit oxidation of anthocyanins on the surface of particles. Overall, there was no significant difference in phenolic, anthocyanin content and free radical scavenging activity between the two drying methods, except that the multivalent metal ion reduction capacities of the spray-dried samples were significantly higher than those of the freeze-dried samples. Additionally, spray-dried powder had a substantially greater moisture content than freeze-dried powder. [6]

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