SOME FUNCTIONAL PROPERTIES OF PIGMENT EXTRACTS FROM RED CABBAGE (*BRASSICA OLERACEA*) AND REDBEET (*BETA VULGARIS)*

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***Abstract*— The purpose of the present work was to obtain natural pigments from red cabbage and redbeet. The antioxidant and antimicrobial activities of the fresh pigments were determined. Furthermore, the encapsulation capability and release of the bioactive compounds were analyzed. Pigment extraction was conducted in distilled water with 1% HCl media. The anthocyanin content obtained from cabbage was 8.9 mg /ml and 8.8 mg /ml of betalains from redbeet. The polyphenol content for red cabbage and redbeet were 0.0128 and 0.0123 mg of gallic acid equivalent/g in dry basis, respectively, as determined by Folin-Ciocalteau method.**

The stability of the extracts to UV light and temperature was assessed; polyphenolic and pigment contents decreased after exposure. Pure extracts from these vegetables showed an antimicrobial effect under ambient conditions, as well as an inhibitory activity against *Staphylococcus aureus.* However, no antimicrobial effect was detected for the pathogen *Aspergillus niger*. The extracts were successfully encapsulated in calcium alginate beads; an additional coating of chitosan was applied.

***Keywords*— Red cabbage; Redbeet; Anthocyanins; Betalains; Encapsulation.**

I. INTRODUCTION

Synthetic additives, which include antimicrobials, stabilizers, antioxidants and pigments, are commonly found in food formulations. However, consumer preferences favor natural substances. Thus, there is a continuous search for additives from natural origin obtained by non contaminating technologies (Sapers *et al.*, 1981; Giusti and Wrolstad, 2003; Valenzuela *et al.*, 2003). Particularly, the use of synthetic red dyes are under discussion; therefore, finding red pigments from natural sources become necessary. Natural pigments include several chemical compounds, like anthocyanins, betalains and carmine.

Some of them have additional properties like antioxidant or antimicrobial activities. Within the polyphenolic compounds, anthocyanins have several beneficial effects such as antioxidant and anti-inflammatory capacity; also they may increase blood vessel health, among other helpful aspects (Heo and Lee, 2006). According to Hall (2001) and Giusti and Wrolstad (2003), the betacyanins and betaxanthins present in redbeet *(Beta vulgaris L. var esculenta)* and anthocyanins found in red cabbage (*Brassica oleracea L. var capitata*) have antioxidant activity.

From *Brassica* specie, Brussel sprouts, broccoli and red cabbage have some of the highest antioxidant activity (Podsedek, 2007; Sikora *et al*., 2008). Podsedek (2007) reported that the hydrophilic antioxidants in *Brassica* vegetables are responsible for more than 89% of the total antioxidant capacity. Besides, some polyphenolic compounds used as food additives inhibit microbial growth (Estévez and Cava, 2006). To improve the pigment handling, in the present work an encapsulation technique of the extracts was implemented. Encapsulation is a process where a polymer covers small solid particles, liquid droplets or gases (Shahidi and Han, 1993; Deladino *et al.*, 2008). These systems have the property of protecting the core substance and allow it to be released in a controlled manner. Additionally, they can solve some functional issues such as manipulation, increase solubility, etc. (Abreu *et al*., 2008).

Therefore, the aims of the present work were i) to obtain pigments from red cabbage and redbeet, ii) to explore additional properties of the pigments like antioxidant, antimicrobial activity as well as stability of the fresh pigments and iii) to encapsulate these vegetal extracts.

II. METHODS

A. Pigment Extraction from Red Cabbage and Redbeet

Red cabbage (*Brassica oleracea*) and redbeet (*Beta vulgaris)* were obtained from the local market; they were washed, cut and later placed individually in a flask with a vegetable:solvent ratio of 1:10.

Extraction was carried out using different solutions a) water, b) water and HCl 1%, c) HCl 1% aqueous solution:ethanol (1:1). Cut vegetables were processed using magnetic agitation for 16-18 hours at ambient temperature. Then, they were filtered with Whatman #1 paper and kept in a colored glass flask at 0ºC.

B. Extraction yield

The total dry matter content was determined by drying in an oven at 100 ºC until constant weight (AOAC, 2004). Assays were performed in triplicates.

The extraction yield of the process was calculated considering the extract weight in dry basis and the initial weight of the fresh vegetables.

$$Y(\%) = 100\,\frac{Weight\ \ of\ \ extracted\ \ \ pigments\ \ (g, db)}{Weight\ \ of\ \ fresh\ \ vegetables\ \ (g)} \qquad (1)$$