Microencapsulation of pomegranate peel phenolics

Çam, M*. and İçyer, N.C.
Erciyes University, Department of Food Engineering, Kayseri, Turkey (mcam@erciyes.edu.tr)

INTRODUCTION

Pomegranate (*Punica granatum* L.) is an edible fruit which has been used extensively in the folk medicine of many cultures. Almost 40% of the whole fruits are the peels, rich in ellagitannin type of phenolics called punicalagins. In our previous studies, we proved that phenolics of pomegranate peels have anti-oxidative (Cam, 2010), and anti-diabetic (unpublished results) properties.

In food industry, microencapsulation techniques have been widely used aiming at to protect food components from being deterioration. Among microencapsulation techniques, spray drying is by far the most commonly used technique, on account of being a continuous, low cost process that produces dry particles of good quality, and for which the machinery is readily available (Fang 2011). Phenolics are prone to oxidation and are not stable in their solvent extracted form. Spray drying might be convenient method for phenolics, exposure to inlet temperature in seconds, and the outlet temperature is less than 100 °C.

The aim of the study was to develop a spray drying method for microencapsulation of phenolics in pomegranate peels.

MATERIALS AND METHODS

Materials

Pomegranate peels as by-product of fruit juice industry were provided from a local producer (Göknur, Niğde, Turkey). The peels were dried in a shadowed environment. Four type of maltodextrins, Maldex G150 (DE 14-17) and Maldex 190 (DE 18-20) were obtained from Syral Co., and two other maltodextrins having DE of 13-17 and 16.5-19.5 were obtained from Aldrich Co. The rest of the chemicals and standards were of analytical grades and obtained from Sigma or Merck Co.unless stated otherwise.

Methods

Extraction Phenolics

Phenolics were extracted using previously optimized conditions at 100°C for 1 min.

Total Phenolic Content of microcapsule

Total phenolics were determined in powders after water extraction at 100°C for 1 min.

Phenolic content on microcapsule surface

Phenolics on the microcapsule surface were determined after ethanol extraction (Zhang 2007)

UPLC Phenolics

Individual phenolics were determined by a reversed phase ultra pressure liquid chromatography system combined with DAD (Shimadzu, Kyoto, Japan).

Preparation of Infeed Solution

Phenolic extracts were diluted to equivalent concentration of gallic acid as 2 g/l followed by maltodextrin addition under continuous mixing at 10000 rpm with an Ultra-Turrax homogenizer. The mixtures were homogenized additional 10 min. Every spray drying experiment was conducted using 200 ml portion of the mixture.

Microencapsulation by Spray Drying

The mixtures were fed to a Buchi B-290 spray dryer (Switzerland).Effects of three factors, inlet drying temperature, core to wall ratio, and type of maltodextrin were investigated to find optimum conditions by changing one factor's level while keeping the other factors as constant. The air flow rate (600 l/h), rate of feeding (8 ml/min), and nozzle cleaning pulse (1/min) were kept constant throughout all the experiments. The microcapsules were transferred into a plastic container and stored in +4 °C in a desiccators preventing light contact.

Yield and Effectiveness of Microencapsulation

The yield, Y, (Fang 2011), and the effectiveness, E, (Zhang 2007) were calculated according to the formulas based on dry matter content:

$$Y(\%) = \frac{\text{Mass of microcapsules (g)}}{\text{Total mass of initial substances (g)}} * 100$$

$$E(\%) = \left(1 - \frac{\text{Phenolics on microcapsule surface}}{\text{Total phenolics of microcapsule}}\right) * 100$$

RESULTS AND DISCUSSION

Effects of Temperature on Microencapsulation

Effects of inlet air temperature on microcapsules are shown in Figure 1. Effectiveness was more than 98%, and almost the same for tested temperatures. This was mostly because of core to wall material ratio, kept constant at this stage as 1:6. Effectiveness is the indication of phenolics retained in wall material.

Productivity was increased up to 160 °C, and kept almost constant at temperatures higher than 160 °C. Air inlet temperature was selected as 160 °C for the next stage.

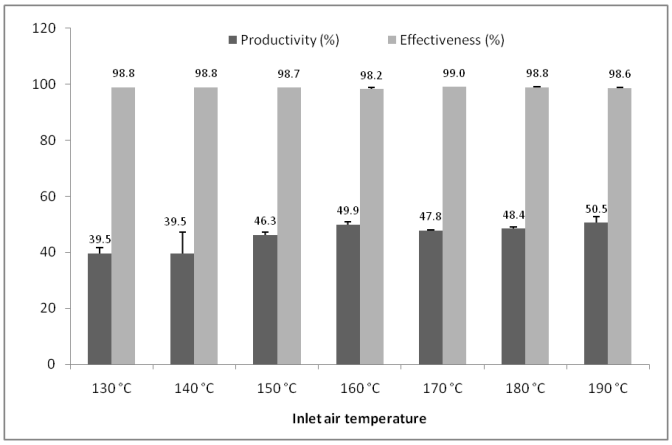

Figure 1. Effects of temperature

Effects of Core to Wall Ratio on Microencapsulation

Effectiveness was almost the same for four ratio level (Figure 2). Effectiveness is an indication of the phenolics stayed on the surface. If the amount of phenolics on the surface is high, microcapsules might be more susceptible to oxidation.

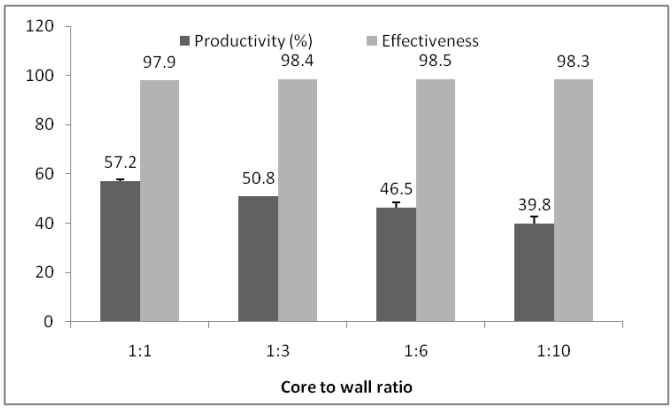

Figure 2. Effects of core to wall ratio

Effects of Maltodextrin Type on Microencapsulation

Maltodextrins from different sources having certain dextrose equivalency were tested as wall materials.

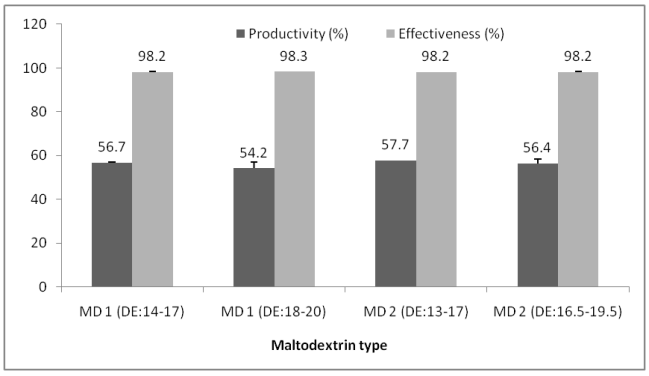

Figure 3. Effects of wall material type

Effectiveness and productivity values of four different types of maltodextrins were not different (Figure 3).

Optimum conditions for microencapsulation might be suggested as follows: 160 °C for inlet temperature, 1:1 (w/w) or 1:3 (w/w) for core to wall ratio, and any of the maltodextrins tested here according to the purpose. Dextrose equivalency of maltodextrins may affect the sweetness of final product to which microcapsules are to be added. Microcapsules having 1:3 (w/w) core to wall ratio might be higher stability for long term storage than microcapsules of 1:1 (w/w) core to wall ratio. Higher proportion of wall materials displayed no observable positive effect on microcapsules.

Phenolics by UPLC

Nine phenolics were determined in pomegranate peels of which punicalagins were the dominant components (Figure 4). The amount of phenolics, determined by UPLC, in microcapsules having 1:1 (w/w) and 1:3 (w/w) core to wall ratio were 311.1±10.3, and 172.1±1.1, respectively.

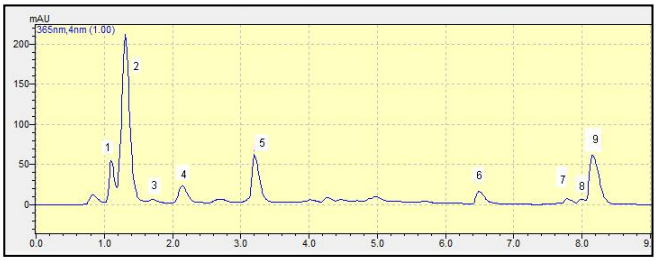

Figure 4. Phenolics of microcapsules by UPLC (1, 2, 3, 4, and 5: punicalagins; 6, 7, and 8: ellagic acid derivatives; 9: ellagic acid)

CONCLUSIONS

It can be concluded that phenolics of pomegranate peels might be effectively microencapsulated by proposed method. Microcapsules seem to be suitable materials for functional food production.

REFERENCES

- Cam M. et al. (2010). *Pressurised water extraction of polyphenols from pomegranate peels.* Food Chemistry, 123(3), 878-885.
- Fang Z. et al. (2011). *Effect of spray drying and storage on the stability of bayberry polyphenols*. Food Chemistry, 129(3), 1139-1147.
- Zhang L et al. (2007). *Procyanidins: Extraction and micro-encapsulation.* Journal of the Science of Food and Agriculture, 87(12), 2192-2197.

ACKNOWLEDGEMENT

This work has been financially supported by the Scientific and Research Council of Turkey (TUBITAK) under the Project Number of 110O594.