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Extended Abstract

Investigating Characteristics of Encapsulated Sumac Extract Powder with Spray Drying and the Effect of Different Storage Conditions on its Phenolic Compounds and Antioxidant Activity

Nasrin Malekizadeh[1], Seyed Hadi Peighambardoust[2*], Aref Oladghaffari[3], Khashayar Sarabandi[4]

1- MSc graduated, Department of Food Science, College of Agriculture, University of Tabriz, Tabriz, Iran

2- Professor of Food Technology, Department of Food Science, College of Agriculture, University of Tabriz, Tabriz, Iran

* Corresponding author (peighambardoust@tabrizu.ac.ir)

3- Academic Staff of Food Research Group, Food and Agriculture Research Department, Standard Research Institute (SRI), Karaj, Iran

4- PhD Student, Faculty of Food Science & Technology, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran

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Abstract

Due to the microbial problems arising from the maintenance of spices and also flavor and color losses of the product during storage, encapsulation of spices extract is an appropriate solution that has been suggested by some researchers. Three different inlet air temperatures (140, 160 and 180 °C) and different maltodextrin (DE=18-20) concentrations (10, 20 and 30%) on bulk and tapped density, flow-ability, total phenolic content and antioxidant activity of spray dried sumac powders were investigated. Also the phenolic content and antioxidant activity, in three different storage conditions (light 20 °C, darkness 20 °C and 6 °C) for 90 days were investigated. The results demonstrated that with increasing inlet air temperature and maltodextrin concentration, the flow- ability of samples increased, while bulk density, tapped density and total phenolic content decreased. The antioxidant activity of the samples also decreased with increasing inlet air temperature and decreasing maltodextrin concentration. Considering 90-days storage results, lower temperatures in darkness conditions, seems to be the best choice for a long period storage of the spray dried sumac powders.

Keywords: Microencapsulation, Properties, Spray drying, Storage, Sumac

Introduction

Sumac's fruit contains phenolic compounds such as flavonoids, tannins, anthocyanins and organic acids, which with their antioxidant activity, lead to anti-cancerous effects. Today, there is an increase in demand for natural antioxidants instead of synthetic additives. The microencapsulation of the spice extract has been suggested by the researchers for the preservation of aroma and flavour compositions as well as pigments in spices (Kanakdande *et al*., 2007; Krishnan *et al*., 2005). Stabilizing of food ingredients or increasing their bioavailability is one of the most important reasons for the encapsulation of active compounds (Desai & Park, 2005; Shahidi & Han, 1993). One of the most common methods of food encapsulation is spray drying. Ersus & Yurdagel (2007) spray dried black carrot extract with maltodextrin and showed that storage at 4 °C increases the anthocyanins, 3 times more than storage at 25 °C. The results of Fang & Bhandari (2011) showed that spray dried berries should be kept at a temperature less than 25 °C for persistence of polyphenols. In this study, the spray dried sumac powder was evaluated in terms of bulk and tapped density, angle of repose, Cohesiveness index, compressibility index, moisture content, phenolic compounds and antioxidant activity. Powders were stored for 90 days under three conditions: darkness 6 °C, darkness 20 °C, and brightness at 20 °C. At the end of day 90, total phenolic content and antioxidant activity of the powders were evaluated. In all experiments, outlet air temperatures, atomizer rotational speed, feed flow rate and atomizer air pressure were kept constant at 80 °C, 18000 rpm, 20 mL/min and 4±0.1 bar, respectively.

Material and methods

Bulk and tapped density

2 g of sumac powder was poured into a 10 mL graduated cylinder and both the bulk and tapped density was obtained from the mass ratio of the powder to the volume occupied in the cylinder (Goula *et al*., 2004, Goula & Adamopoulos, 2008a).

Angle of ripose

10 g of sumac powder was weighed and passed through the hopper at a constant height, to a flat horizontal surface and to form a mass. The angle of ripose was calculated from the angle formed by the slope of the product mass to the datum level (Bhandari *et al*., 1998).

Determination of cohesiveness and compressibility index

Flowability and cohesiveness of the powder were evaluated in terms of Carr index (CI) (Carr, 1965) and Hausner ratio (HR) respectively (Jinapong *et al*., 2008). Both CI and HR were calculated from the bulk (BD) and tapped (TD) densities of the powder as shown below:

$$HR = TD/BD \qquad (1)$$

$$CI = \frac{(TD - BD)}{TD} \times 100\% \qquad (2)$$

Moisture content

The moisture content of the samples was determined by thermal weighing method (Iranain National Standardization Organization [ISIRI], No. 2705, 2010).

Phenolic compounds

The amount of phenolic compounds in powder and sumac extract was measured with a slight change in the Folin-Ciocalteu method (Singleton & Rossi, 1965). The total phenol content was based on mg of gallic acid per gram of sumac extract powdered.

Effectiveness of encapsulation

Capsulation efficiency was calculated as the amount of the powder's phenolic compounds to the primary raw mixture's phenolic.

Antioxidant activity

The ability to inhibit free radicals was determined by the Brand-Williams *et al*. (1995) method with a slight change. The percentage of inhibtion was calculated from below relation:

$$\%\ Inhibition = 1- (A_{Sample} / A_{Control}) \qquad (3)$$

Extended Abstract

A_{sample}= the absorbance of sample and $A_{control}$= the absorption of control.

Results and discussion

Bulk and tapped density

By increasing the air temperature and concentration of maltodextrin, the bulk and tapped density of powders decreased(P<0.05). With increasing the drying temperature and maltodextrin, it is possible to produce particles with less wrinkling, which increases the size of the particles and increases the porosity and also free space between the particles, thus decreasing the density (Santhalakshmy, 2015; Mishra *et al*., 2014; Kha *et al*., 2010; Goula & Adamopoulos, 2005b).

The angle of repose

Measuring the angle of repose is a method for evaluating of powders flowability. With temperature and maltodextrin increasing, powder's angle of ripose significantly (P<0.05) decreas and the flowability increase.

Cohesiveness and compressibility index

Another method for evaluating the flowability of powders is to determine the Hausner ratio. The effect of inlet air temperature and maltodextrin concentration on the Cohesiveness and compressibility index of the powders were not statistically significant (P<0.05).

Phenolic compounds

The efficiency of encapsulation, in this study was 84-97%. By increasing drying temperature and maltodextrin concentration, the amount of phenolic compounds decreased significantly(P<0.05). Phenolic compounds are sensitive to high drying temperatures. It has also been reported that powders which spray dried at lower temperatures tends to become agglomerate due to higher moisture content. Agglomeration results in less exposure of powders to oxygen and therefore protects phenolic compounds from degradation (Quek *et al*., 2007; Goula *et al*., 2004). The increase in carrier concentration leads to the dilution and reduction of nutrients such as phenolic compounds of the extract (Mishra *et al*., 2013).

Antioxidant activity

The inhibition percent of sumac extract powder was in the range of 86-89%, indicating a good inhibition percent of sumac. With increasing drying temperature and decreasing the maltodextrin concentration, the antioxidant activity of sumac powder was reduced (P<0.05). The increase in temperature reduced the compounds with antioxidant activity because they are sensitive to heat. By increasing the concentration of maltodextrin due to the protective and micro-coating effect of maltodextrin, it will further protect antioxidant compounds (Shahidi *et al*., 2014; Kha *et al*., 2010).

Effect of storage conditions on phenolic compounds

According to the results, phenolic compounds of sumac extract powder increased slightly but significantly during 90 days in all storage conditions (P<0.05). The increase was due to structural changes in phenolic compounds during the Time. Maintaining stability in phenolic compounds during long storage periods is more appropriate in low temperature and dark conditions, because light and also high temperatures increase the disintegration rate of phenolic compounds (Paini *et al*., 2015; Pesek & Warthesen, 1987).

Effect of storage conditions on the antioxidant activity

The results showed that in all storage conditions, the antioxidant activity of the sumac extract was stable because the increase in antioxidant activity after 90 days was very slight and at most about 1%. The results of some researchers suggest that at higher storage temperatures, the antioxidant capacity is reduced (Fang & Bhandari, 2011). The hydrolysis of hydrolyzable tannins can improve antioxidant activity by increasing the number of free hydroxyl groups (Aaby *et al*., 2007).

Conclusion

In this research, Physical and chemical characteristics were significantly (P<0.05) affected by the temperature and maltodextrin concentration (except Cohesiveness and compressibility index). The 90 day storage results indicate that maintaining phenolic compounds in long-term storage is preferable in low temperature and dark conditions. Also, the antioxidant activity of sumac extract powder was stable in all storage conditions. Due to the reduction and dilution of phenolic compounds and the increase in costs, it is not recommended to increase the carrier concentration and the concentration of maltodextrin 20% can be as Optimized concentration. High inlet temperatures, cause to the loss of phenolic and antioxidant compounds, so the temperature of 160 °C can be introduced as the optimum drying temperature of the sumac extract powder.

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