Microencapsulation of carvacrol using spray drying method

Wu Y., Wang Q., Yang Y.
Guelph Food Res Centre, Agriculture & Agri-Food Canada Guelph, Canada (wuy@agr.gc.ca)

INTRODUCTION

Carvacrol is a type of essential oils with proven antimicrobial activities. It is readily absorbed in upper gastric tract such as stomach if not protected in encapsulates. Encapsulation of carvacrol has been investigated for better antimicrobial effect in our previous studies in order to deliver carvacrol into lower intestinal tract where most pathogenic bacteria harbor. In the present study, carvacrol was encapsulated using spray drying method. Spray drying is a type of conventional methods for encapsulation (Jafari et al., 2008). Some materials such as whey protein, maltodextrin and gum Arabic were applied as wall materials in this technique. Some wall materials are readily dissolved in water and do not provide protection over core material (carvacrol in the current study) for target delivery into lower intestinal tract. Aiming at a better protection over carvacrol, polysaccharides including pectin and fenugreek gum were applied as wall materials for encapsulation using spray drying method. These materials were mixed with maltodextrin and gum Arabic at various ratios. The relationship between emulsion properties such as viscosity and oil droplet size, and the encapsulation efficiency and particle size of the dried encapsulates was investigated.

MATERIALS AND METHODS

Materials

Carvacrol, maltodextrin, gum Arabic, pectin, were purchased from Sigma-Aldrich (Okeville, Canada). fenugreek gum provided by Emerald Seeds (Canafen Gum® Saskachewan, Canada).

Preparation of emulsions

All polysaccharides were weighed, mixed and dispersed in water at 70°C for 1 hr with constant stirring. The final polysaccharides concentration is 20% (w/w). Carvacrol was slowly added into the well dissolved polysaccharide solution at the appropriate ratios. Polytron was used for 5 min at level 5 for homogenization. The freshly prepared emulsion was used for spray drying, viscosity determination and emulsion property tests.

The formula of different polysaccharide composition was presented in Table 1.

Table 1: Composition of wall materials and oil to solid ratios as different treatments

Treatment	Polysaccharide (g)		Maltodextrin (g)	Gum Arabic (g)	oil/solid ratio
1		0	3	6	1/9
2		0	3	6	2/9
3		0	3	6	3/9
4		0	3	6	4/9
5		0.5	2.5	6	1/9
6	Pectin	1	2	6	1/9
7		2	1	6	1/9
8		0.5	2.5	6	4/9
9		0.5	2.5	6	1/9
10	Fenugreek	1	2	6	1/9
11	Gum	2	1	6	1/9
12		0.5	2.5	6	4/9

Emulsion properties and viscosity

Droplet size distribution was determined using Zetasizer Nano-ZS (Malvern Instruments, Worcesstershire, UK). Emulsion was diluted with water at 1:50 emulsion to water ratio. The droplet size distribution was recorded as the mean particle diameter (z average, nm). Viscosity of the emulsion was measured on a strain controlled ARES Rheometer (TA Instruments, New Castle, DE). Viscosity was determined by cone-and-plate geometry (4º, 50 mm) with shear rate from 0.01-100s-1.

Encapsulation of carvacrol using spray drying

Emulsion was loaded onto the ADL310 Spray Drier (Yamato Scientific Co. LTD., Santa Clara, USA) with inlet temperature of 150 C, outlet temperature of 90C at pressure 0.1 mPa.

Particle size of microencapsulates

The particle size of the spray dried encapsulates were measured using Fritsch NanoTec “analysette 22” Laser Particle Sizer (Germany). Samples were measured under Dry Dispersing Unit with the air pressure at 3 to 4 bar. Particle size was presented as Geometrc diameter (um).

RESULTS AND DISCUSSION

Powder particle size

Results on particle size of the encapsulate were presented in Figure 1.

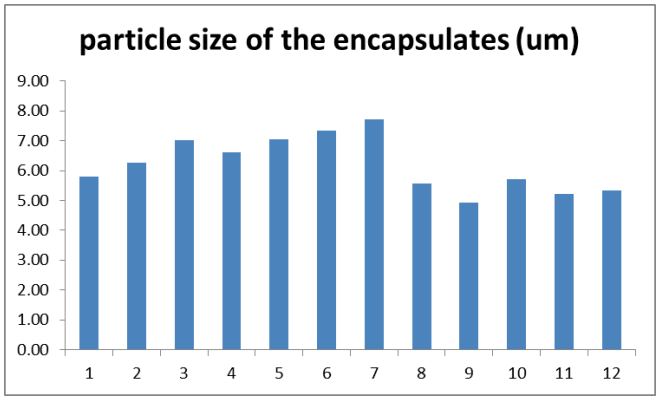

Figure 1. Particle of spray-dried encapsulates.

According to Table 1, treatment 1 to 4 were encapsulates contained only maltodextrin and gum Arabic. Treatment 5 to 8 contained pectin, and treatment 9 to 12 contained fenugreek gum. Figure 1 showed that addition of fenugreek gum led to smaller particles. Treatment 4, 8 and 12 were at oil to solid ratio of 4 to 9. The particles sizes were not affected by the higher oil to solid ratios. Instead, there is a tendency that the particles became smaller compared to the same polysaccharide compositions with lower oil concentrations.

Encapsulation efficiency

Encapsulation efficiency was measured using Gas Spectroscopy and results were presented in Figure 2. Carvacrol on the surface of the particles and inside the particles were measured respectively.

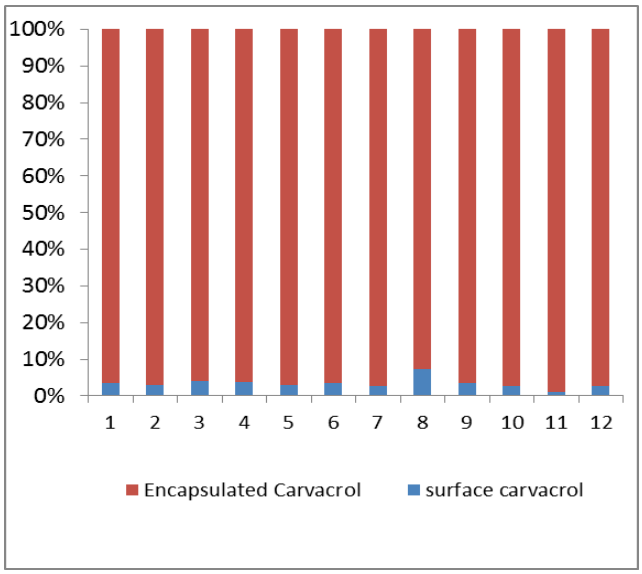

Figure 2. Encapsulation effiency of spray-dried particles

No obvious difference was observed among different treatments. Composition of polysaccharides and oil/solid ratio did not show any effect on the encapsulation efficiency.

Effect of viscosity

Viscosity of emulsions at shear rate 1 (s^{-1}) was presented in Figure 3. Treatment 7 and treatment 11 were compositions with 2 g pectin and fenugreek gums respectively. Thus higher viscosity were obtained. However, the dried particle size and encapsulation efficiency were not affected by the higher viscosity values.

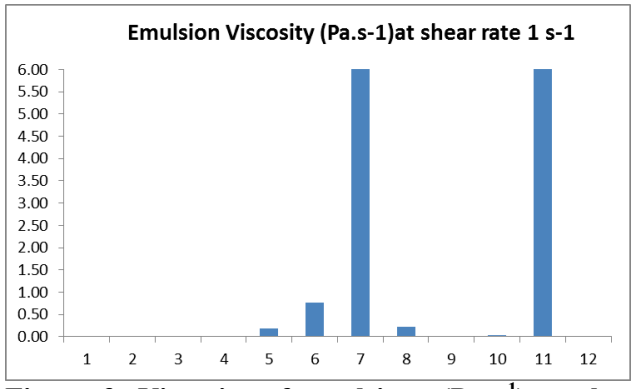

Figure 3. Viscosity of emulsions ($Pa.s^{-1}$) at shear rate 1 (s^{-1}).

Effect of emulsion oil droplet size

Figure 4 provided the results of droplet size. Higher concentration of oil led to larger droplet size in emulsion. However, encapsulation efficiency was not affected by the emulsion properties.

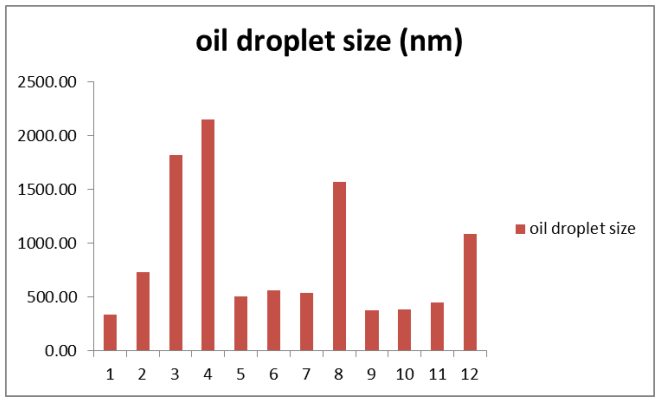

Figure 4. Emulsion droplet size

CONCLUSIONS

Addition of different polysaccharides can affect the dried particle size. Different polysaccharides exhibited different degree of effect. Addition of fenugreek gum showed better effect at higher oil concentrations..

REFERENCES

- Jafari S. et al., (2008) *Encapsulation efficiency of food flavours and oils during spray drying* et al.Dring Technology, 26:816-835.