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EFFECT OF FLAVOUR LOAD AND INLET AIR TEMPERATURE ON MICROENCAPSULATION OF VANILLA EXTRACT WITH MALTODEXTRIN AS WALL MATERIAL

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ABSTRACT

Microencapsulation of vanilla extract with maltodextrin as wall material to protect the vanillin compound (major aroma composition of vanilla) against its highly volatile and heat sensitive nature by spray drying technique was studied. The effect of predominant process variables, the flavor load and spray drier inlet air temperature, were evaluated. The wall material maltodextrin was emulsified with 10, 20 and 30% of vanilla extract (flavor load) with 50% solid content and spray dried at inlet temperatures of 170, 180 and 190^{0}C. The encapsulated powder characteristics were found and analyzed. The encapsulation efficiency increased with increase in temperature and decreased with increase in flavor load. The study concluded that the microencapsulation of vanilla extract with maltodextrin as wall material and a flavor load of 10% spray dried with an inlet air temperature of 190^{0}C showed higher encapsulation efficiency and produced superior quality encapsulated powder and therefore found to be optimum process parameters.

KEYWORDS: Encapsulation Efficiency, Maltodextrin, Microencapsulation, Vanilla Extract

INTRODUCTION

Vanilla (*Vanilla planifolia)*, the only member of *Orchidaceae* family has high economic value in the food and related industries, because of its unique flavor and pleasant aroma. The aromatic compound Vanillin present in vanilla is responsible for its flavor and aroma. It is used as flavorings in ice-creams, soft drinks, candy, chocolate, confectionary, baked foods, puddings, cakes, cookies etc. Vanillin is highly volatile and heat sensitive and flavor retention is limited. Microencapsulation of extract with suitable wall material can protect the flavour from undesirable interactions with food, reduces off-flavour, minimize the oxidation, increase shelf-life, allow a controlled release and retain aroma in a food product during storage.

Spray drying microencapsulation is the technique by which the preserved (active) material is entrapped within a protective (wall) material wherein the feed solution is transformed into a solid powder, forms a continuous matrix surrounding the active substances of micro particles after a short drying period. The feed liquid, the emulsion of wall material and core material in water is sprayed into heated air in the spray drier. The heated air supplies the latent heat of vaporization required to remove the solvent from the wall material, thus forming the microencapsulated product. Maltodextrin as wall material permits increased solid content with low viscosity which improves encapsulation efficiency, reduces oxidation, and is economical.

Flavor load and spray drier inlet temperature are the predominant process variables that affect the quality characteristics of the encapsulated powder and encapsulation efficiency and therefore needs to be optimized. The objective of this study was to standardize the flavor load (vanilla extract concentration) and inlet air temperature of the spray drier of the microencapsulation process based on the quality characteristics of the encapsulated powder such as moisture content, bulk density, solubility, wet ability, and encapsulation efficiency.

MATERIALS AND METHODS

Emulsification and Spray Drying

Vanilla extract was supplied by M/s. Silver Wings Agencies (Waynad, Kerala, India) and the wall material maltodextrin was procured from M/s. Viveka agencies (Coimbatore, Tamil Nadu, India). Two hundred and fifty gram of maltodextrin was dissolved in 300 ml of distilled water by continuously stirring it and after complete dispersion; the final volume was made up to 500 ml by adding distilled water. The resultant 50% solid carrier solutions were filtered using muslin cloth to remove the foreign materials. These solutions were then fortified with 25, 50 and 75 g of vanilla extract to obtain a flavour load of 10, 20 and 30 per cent (w/w) of the wall solids respectively (Fernandes *et al.,* 2008). Two drops of Tween-20 was added to enhance the emulsifying and film forming properties (Krishnan *et al*., 2005). The mix was then emulsified in a high-speed mixer until the vanilla extract was dispersed completely. sThe emulsions were then spray dried in tall type spray drier with two fluid nozzles (M/s S.M. Scientech, Kolkata, India). The feed pump (peristaltic pump) was adjusted to 12 ± 1 rpm and the air pressure for the twin fluid pressure nozzle was adjusted to 2 ± 0.1 kg/cm^2 and the blower speed was adjusted to 2000 ± 5 rpm. The emulsions were dried at different inlet air temperature such as 170 ± 2^0C, 180 ± 2^0C and 190 ± 2^0C. The microencapsulated vanilla extract powder was then collected from glass bottles of both drying chamber and cyclone separator which are then mixed thoroughly and packed in aluminium foil pouches, sealed air tight and stored at room temperature 32 ± 2^0C for further analysis.

Microencapsulated Powder Characteristics

Moisture Content and Cold Water Solubility

The moisture content of the encapsulated powder was determined by the AOAC method (AOAC, 1999). To analyze the cold water solubility of spray dried encapsulated powder, the method proposed by Loksuwan (2007) was used. One gram of microencapsulated vanilla powder was mixed with 100 ml of water at room temperature for 30 min. A 10 ml aliquot of the supernatant solution was transferred to a 15 ml centrifuge tube and centrifuged for 15 min. The aliquot of the supernatant was then taken in a pre-weighed aluminum moisture dish, evaporated on a steam bath and dried in an oven at 110°C overnight. The cold water solubility was calculated as:

$$\text{Cold water solubility, \%} = \frac{4 \times \text{Grams of solid in supernatent}}{\text{Grams of sample}} \times 100$$

Wettability and Bulk Density

Wettability was determined by taking 1.5 gm of encapsulated vanilla extract powder which was then gently placed on the surface of 100 ml water at 30°C. The time for the powder to get completely wet was noted. The method suggested by Bhandari *et al*. (1992) was used to obtain the bulk density. Two grams of microencapsulated vanilla powder was loosely weighed into a 10 ml graduated cylinder. The cylinder was tapped on a flat surface to a constant volume. The final volume of the vanilla powder was recorded and the bulk density was calculated by dividing the sample weight by volume.

Encapsulation Efficiency

Encapsulation efficiency is the amount of extract entrapped inside the wall material to the total amount of the extract present in the powder. Total extract content of the powder sample was estimated by standard ASTA method (ASTA, 1968). Surface (non-encapsulated) extract content was determined by a modified method suggested by Varavinit *et al*. (2001). Hexane (50 ml) was added to an accurately weighed quantity (5 g) of encapsulated powder followed by stirring for 2 minutes. The suspension was then filtered and the residue rinsed twice by passing 20 ml of hexane. The residual powder was then air dried for 30 min. and weighed. The amount of surface extract content was calculated by the difference in weight of the encapsulated powder, before and after washing. The encapsulation efficiency was calculated using following equation.

$$\text{Encapsulation efficiency, \%} = \frac{\text{Total amount of extract - surface extract conent}}{\text{Total amount of extract}} \times 100$$

Statistical Analysis

The effect of flavor load and inlet air temperature of microencapsulation of vanilla extract on different quality parameters were statistically analysed as completely randomised design (CRD). Post Hoc test (DMRT- Duncan's Multiple Range Test) was performed to identify the subgroups of treatments and statistical significance at $p<0.05$. The statistical analysis of data was carried out using SPSS software (Version 16.0; SPSS Inc. Chicago).

RESULTS AND DISCUSSIONS

Effect of Process Variables on Microencapsulated Vanilla Extract Powder

Moisture Content

The moisture content of the encapsulated powder varied significantly ($p<0.05$) with inlet air temperature but variation was insignificant with flavor load (Figure 1 (a)). The moisture content varied between 4.1 and 5.52% (w.b.). With increase in flavor load, an insignificant increase in moisture content was also reported by Sankarikutty *et al.* (1988) during spray drying encapsulation of cardamom oil. With increase in inlet air temperature, the temperature differential between heated air and drying particles increased reducing relative humidity of the drying air which could hold more moisture leading to the lowering of moisture content of the encapsulated powder.

Cold Water Solubility

The cold water solubility of the encapsulated powder varied significantly ($p<0.05$) with flavour load and inlet air temperature (Figure1 (b)). With the increase in inlet air temperature, the amyl pectin branched chain length could have broken contributing to the increased solubility. When flavour load was enhanced, the hydrophilic wall material available would be limited to produce a strong structural matrix resulting in thinner layers of wall material between encapsulated oil droplets (Mc Name, *et al*., 1998).

Wettability

Significant increase in wettability (decrease in wetting time) was noticed with increase in flavour load. As the flavour load was incremented, the bulk density decreased, which would have reduced the wettability. Also, with increase in flavour load, the surface oil content would have increased, resulting in a decrease of wettability. Wettability depends on powder particle size, density, porosity, surface area and surface activity of powders (Vega and Roos, 2006). With the increase in inlet air temperature wettability was found to increase (Figure1 (c)) which could be attributed to the decreased moisture content of the product that the powder absorbs water and wet the surface fast.

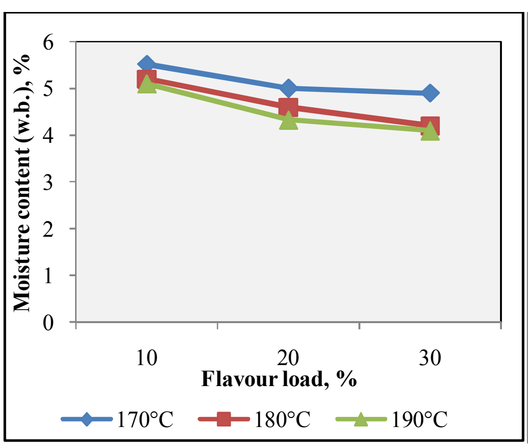
Bulk Density

The bulk density of the encapsulated powder varied insignificantly ($P < 0.05$) with respect to flavour load and inlet air temperature. The bulk density ranged from 0.3 to 0.4 (Figure1 (d)). With increase in flavour load, the emulsion particle size increased resulting in larger sized particles causing a decrease in bulk density. With the increase in inlet air temperature, density powder also increases, which is due to more rapid drying of the particle and fixing of particle size much before the complete removal of water and also due to the steam formation in the drying droplet, causing expansion of particle (Anker and Reineccius, 1998).

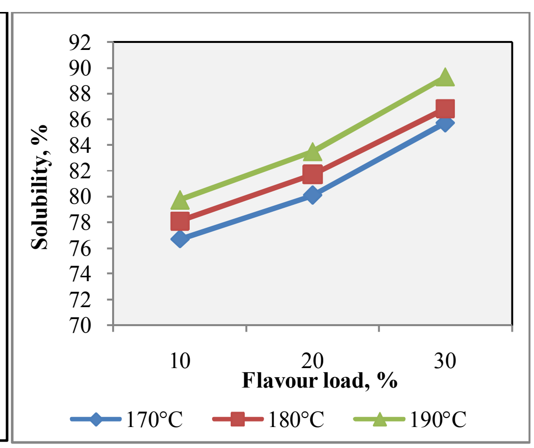
Encapsulation Efficiency

Encapsulation efficiency (EE) as defined by Rosenberg and Sheu (1996) the proportion of the encapsulated flavor that cannot be extracted by a suitable solvent from one gram of microcapsule and its effect of flavor load and inlet air temperature on the encapsulation of vanilla extract varied between 68.3 and 76.6 % (Figure 1 (e)). The encapsulation efficiency (EE) decreased with increase in flavor load. This could be due to the insufficient wall material to produce a sufficiently strong structural matrix and thin layers of wall material between encapsulated oil droplets.

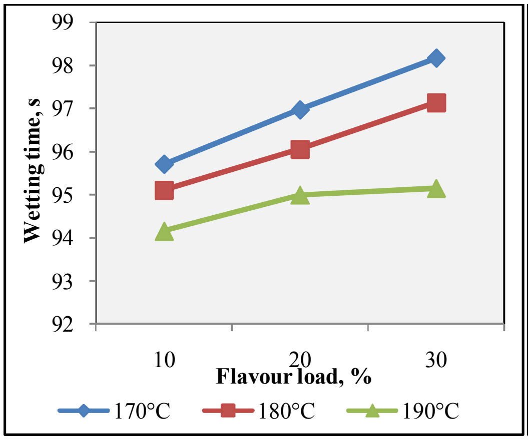
With increase in inlet air temperature, encapsulation efficiency also increased significantly ($p<0.05$). For spray drying in general, increasing drying temperature resulted in greater loss of water due to the higher heat transfer rate into particles, causing faster water removal (Kha *et al.*, 2010) thereby rapid drying occurred which permits quicker formation of semi permeable membrane and accompanied selective diffusion and increased retention.

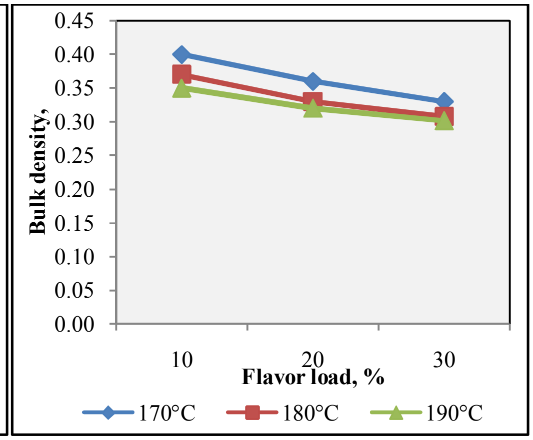


(a)

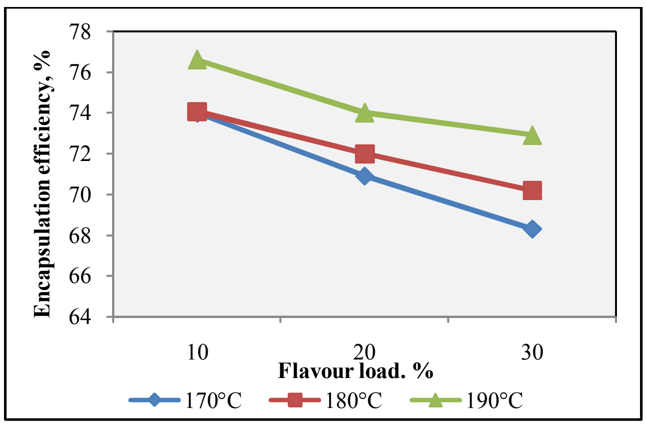


(b)





(c) (d)



(e)

Figure 1: Effect of Flavor Load and Spray Drier Inlet air Temperature on: (a) Moisture Content; (b) Cold Water Solubility; (c) Wettability; (d) Bulk Density; (e) Encapsulation Efficiency of Encapsulated Vanilla Extract Powder

Standardization of Flavour Load and Inlet Air Temperature

Based on the results of the effect of flavour load and inlet air temperature on the predominant quality characteristics of the encapsulated powder, the process parameters responsible for yielding maximum product quality were obtained through statistical analysis. It was found that microencapsulation of vanilla extract with a flavor load of 10% (w/w) spray dried at an inlet air temperature of 190^{0}C produced superior quality encapsulated powder with highest encapsulation efficiency. The encapsulated powder with optimized process parameters were found to exhibit a moisture content 4.8% (w.b), cold water solubility of 79.73%, wettability of 94 s, bulk density of 0.5 g/cm^3, and highest encapsulation efficiency of 76.6%.

CONCLUSIONS

The influence of flavour load and spray drier inlet air temperature on the microencapsulation efficiency and predominant quality characteristics of the spray dried encapsulated powder were analysed. It was found that moisture content, cold water solubility, bulk density, wettability, and encapsulation efficiency of the encapsulated powder were influenced by these process parameters. It was revealed that flavor and aroma in vanilla extract can be protected effectively by microencapsulation using spray drying technique. A flavour load of 10% (w/w) of vanilla extract in the emulsion, encapsulated at an inlet air temperature of 190^{0}C during spray drying showed high encapsulation efficiency and resulted in superior quality encapsulated powder and were chosen as optimum process conditions.

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