Comparative study of microencapsulated green tea extract powder by using freeze and spray drying techniques

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Comparative study of microencapsulated green tea extract powder by using freeze and spray drying techniques

Dipali D Tengse and Priya B*
Department of Food Process Engineering, School of Bioengineering
SRM University, Kattankulathur – 603 203, Kancheepuram
*priya.balasubramani@gmail.com

Abstract
Green tea polyphenols are potential antioxidants, anti-carcinogenic and effective against various disorders. Antioxidant are more sensitive to higher temperature. To improve the stability of antioxidant, green tea extract (25%) was freeze dried at -40°C and spray dried at inlet air temperature 120°C and outlet temperature 100°C using wall materials such as maltodextrin (40%) and core to wall ratio 1:2 to get microencapsulate. spray dried and freeze dried powder evaluated for their quality characteristics such as moisture content, colour, water solubility index, antioxidant activity, total phenolic content. Comparatively Freeze dried encapsulates has higher (76%) antioxidant activity than spray dried encapsulates (73%). Finally spray dried and freeze dried encapsulates were incorporated into ice-cream and sensory analysis were done.

Key words: Antioxidant, phenolic content, maltodextrin, spray drying, freeze drying.

Introduction
Green tea is the most popular form of tea. Green tea is made from Camellia sinensis leaves that have not undergone the oxidation. Many natural substances have been identified in green tea, green tea components theanine and catechins have neurological effects and also inhibit the tumor cells.(Anand Jigisa.et.al., 2012)

The properties of encapsulating polymers play a major role in enhancing the encapsulation efficiency, stability and controlled release of the core material. Maltodextrin has low bulk density, resistance to caking, blandness, excellent mouth feel, film formation, effective binding, oxygen barrier etc. (Esteban Largo Avila et.al., 2015)

Spray drying is the most common drying technology in the food industry for production of dry particles from liquids. (Poshadri.et.al., 2010) It can be used to convert the green tea extract into powder which has longer shelf life than aqueous green tea extract. The aim of this study is evaluation of effect of processing parameters of spray drying and freeze drying on moisture content, colour, water solubility index, antioxidant activity and total phenolic content of spray dried green tea extract.
Materials and methods

Materials

Commercially available organic green tea leaves were purchased from local market of Chennai. Maltodextrin, ethanol, Fohn Ciocalteau reagent, 2, 2-Diphenyl-1-picrylhydrazyl (DPPH) and sodium carbonate were procured from SRL Pvt. Ltd. (Chennai, India). All other chemicals were of analytical grade.

Preparation of feed emulsion

Green tea extract (25%) (GTE) was obtained through two-step extraction as suggested by Vuong et al., 2011 with minor modifications. The obtained green tea extract was used as core material. 40% maltodextrin concentration was prepared as wall materials. The emulsion was prepared with 1:2 core to wall ratio and it’s was then spray-dried using a lab model spray-dryer and same concentration was compared with freeze drying.

Spray drying and freeze drying

The homogenized emulsion was spray dried using a tall form, co current flow and lab scale spray drier. Atomization was carried out by twin-fluid nozzle. The homogenized samples were spray dried at inlet air temperature 120°C and outlet temperature 100°C. The obtained microencapsulated powder was collected in aluminum pouches. The same concentration sample were freeze dried at -40°C to get microencapsulated powder (Pasrija et al., 2015).

Moisture content

Moisture content of the encapsulated powders were measured gravimetrically on a wet basis based on AOAC (2000) method. A known amount of sample was placed in hot air oven (Industrial and laboratory tools corporation, Chennai, India) at 105 ± 2°C for a period of 4h to attain a constant weight. From the initial and final weights, moisture content was calculated by using following formulae.

\[
\% \text{ Moisture content in wet basis} = \frac{\text{Initial wt} - \text{final wt}}{\text{Initial wt}} \times 100
\]

Colour Analysis

The colour of the microencapsulated powder and green tea was measured by using a Hunter colorimeter (Colour Quest XE-Di 8, hunter colorimeter). In order to obtain the L, a*, and b* value for the powder, triplicate samples were analyzed and mean were reported. (Ee et al., 2014)
**Water Solubility index**

The powder sample (1 g) was homogenized in 50 mL of distilled water in a vortex for 30 s. The solution was placed in a tube and centrifuged at 3,000 rpm for 5 min at 25 °C. A 25mL aliquot of the supernatant was transferred to pre-weighed Petri dishes. Then, it was immediately placed in an oven for drying at 105 °C for 5 h. The solubility was calculated as the initial weight minus the final weight divided by the initial weight. (Avila et.al., 2015)

**DPPH radical scavenging activity**

The free radical scavenging activity of the extract was measured in terms of hydrogen donating or radical scavenging ability using the stable free radical DPPH.1mM solution of DPPH in ethanol and also 1mg/1 ml extract solution in ethanol was prepared and 1.5ml of this solution was added to 1.5 ml of DPPH. The absorbance was measured at 517 nm against the corresponding blank solution. The assay was performed in triplicates. (Abdul Qaiyum Ansari et.al.,2013)

\[
\text{%Free radical scavenging activity} = \left( \frac{\text{Control OD} - \text{Sample OD}}{\text{Control OD}} \right) \times 100
\]

**Total Phenolic Content**

The extraction of phenolic content from green tea and microencapsulated green tea powder was carried out. Then samples were mixed with mixture of methanol: distilled water and kept in a rotary shaker for 1 h and polyphenols were extracted by squeezing out. The extract was filtered and centrifuged at 5000 rpm for 10 min for purification. The supernatant was obtained and analyzed for total phenolic content by the Foline Ciocalteu assay as described by the International Organization for Standardization (ISO) 14502-1. The samples were prepared in triplicate for each analysis and the mean value of absorbance was obtained. The same procedure was repeated for the standard solution of gallic acid and the calibration line was construed. Based on the measured absorbance, the concentration of phenolics was read (mg/ml) from the calibration line; then the content of phenolics in extracts was expressed in terms of gallic acid equivalent. (mg of GA/g of extract) (Milan S. Stanković,2010)

**Results and discussions**

**Moisture content analysis**

Results show that spray dried encapsulates had less moisture content than freeze dried encapsulates. This is due to the higher processing temperature (120⁰C) of spray drying compared to that of freeze drying. At higher temperature, moisture content decreased because water evaporate during spray drying (Patrícia et.al., 2013).
### Colour Analysis

Results show that spray dried encapsulates of Maltodextrin with 25% of green tea concentration and 1:2 core to wall ratio showed higher $L^*$ value, $a^*$ value and lower $b^*$ value than freeze drying encapsulates. This is due at higher temperature of spray drying, colour of microencapsulated powder get degrade. (Gulsah Caliskan.et.al.,2015)

<table>
<thead>
<tr>
<th>Sample</th>
<th>$L^*$</th>
<th>$a^*$</th>
<th>$b^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green tea</td>
<td>42.4</td>
<td>-1.59</td>
<td>19.23</td>
</tr>
<tr>
<td>SDMD</td>
<td>82.40</td>
<td>1.96</td>
<td>17.86</td>
</tr>
<tr>
<td>FDMD</td>
<td>79.99</td>
<td>-0.35</td>
<td>18.53</td>
</tr>
</tbody>
</table>

*SDMD – Spray dried microencapsulated green tea powder, FDMD – Freeze dried microencapsulated green tea powder

### Water solubility index

Water solubility index strongly influenced by processing temperature that used in spray and freeze drying process, this is due to the effect of inlet air temperature on residual moisture content. The lower the powder moisture content, the more soluble is the powder. (Lorena Franceschinis.et.al.,2013)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Water solubility index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green tea</td>
<td>76</td>
</tr>
<tr>
<td>SDMD</td>
<td>92</td>
</tr>
<tr>
<td>FDMD</td>
<td>83</td>
</tr>
</tbody>
</table>

### Antioxidant activity

The GTE showed higher antioxidant activity about 82.52% than spray and freeze dried encapsulates of maltodextrin. The processing conditions of the encapsulation process can affect the antioxidant content and their activity. Results show that spray dried encapsulates of Maltodextrin with 25% of green tea concentration and 1:2 core to wall ratio showed lower Antioxidant content (73.46) at 120 °C than freeze dried encapsulates (75.17%). This is due to antioxidant activity decrease as temperature increases, because antioxidant fails to react with free radical as temperature increase (Praveen.et.al., 2007)
Total phenolic content
Encapsulates of Maltodextrin with 25% of green tea concentration and 1:2 core to wall ratio showed lower polyphenol content about 47.96% at 120°C than freeze drying encapsulates. The processing conditions of the encapsulation process can affect the polyphenolic content and their activity. The total phenolic content decreased at higher temperature this may be due to loss of phenolic during drying process (Zuzana Réblová.et.al., 2012)
Sensory Analysis of ice-cream

Conclusion

On comparative study indicated that freeze dried Encapsulates of Maltodextrin with 25% of green tea concentration and 1:2 core to wall ratio showed higher Antioxidant content and Total phenolic content than spray dried encapsulates. Freeze dried and spray dried encapsulates incorporated into Ice-cream. There was no difference on volume and firmness, texture of Ice-cream among with freeze dried and spray dried encapsulates. Fortification of Ice-cream with green tea polyphenols can retain the quality characteristics of Ice-cream along with the functionality. This helps to supplement the polyphenols intake and reduce the degenerative diseases.

References

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