**Materials and Methods**

### 1. Physical Properties

Addition of Gum Arabic (0-75% GA) resulted in a significant increment in water activity ($a_w$), moisture content (MC), hygroscopicity (Hp), wetting time (WT), dissolution (D) and particle size ($d_{50}$) of the powders, however water solubility (WS) decreased (Table 1).

**Table 1. Physical properties of spray dried MD with different amount of GA**

<table>
<thead>
<tr>
<th>Formulation</th>
<th>$a_w$</th>
<th>MC (%)</th>
<th>HP ($g/100g$)</th>
<th>WS (%)</th>
<th>WT (min)</th>
<th>D (µm)</th>
<th>$d_{50}$ (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 MD</td>
<td>0.14 ± 0.02</td>
<td>3.87 ± 0.52</td>
<td>6.25 ± 0.26</td>
<td>95.65 ± 1.51</td>
<td>9.60 ± 0.95</td>
<td>20.58 ± 1.27</td>
<td>12.44 ± 1.03</td>
</tr>
<tr>
<td>75:25 GA</td>
<td>0.13 ± 0.00</td>
<td>4.20 ± 0.61</td>
<td>6.50 ± 0.30</td>
<td>93.19 ± 2.05</td>
<td>41.56 ± 7.65</td>
<td>31.66 ± 3.62</td>
<td>20.78 ± 1.55</td>
</tr>
<tr>
<td>50:50 GA</td>
<td>0.12 ± 0.01</td>
<td>4.98 ± 0.52</td>
<td>6.69 ± 0.42</td>
<td>93.03 ± 2.01</td>
<td>54.96 ± 7.95</td>
<td>34.95 ± 1.65</td>
<td>20.75 ± 1.23</td>
</tr>
<tr>
<td>25:75 GA</td>
<td>0.10 ± 0.05</td>
<td>5.65 ± 0.18</td>
<td>8.37 ± 0.41</td>
<td>92.20 ± 3.01</td>
<td>70.30 ± 10.23</td>
<td>41.84 ± 3.10</td>
<td>21.02 ± 0.55</td>
</tr>
</tbody>
</table>

a, b, c, d: Means followed by different letters within the same column are significantly different at p < 0.05.

### 2. Microstructural Properties

To determine the morphology, powders were dispersed in silicon oil prior observation with light microscopy (Fig 1):

- **Smooth particle** → hollow (identified as a dark circular area)
- **Dented particle** → hollow or solid

![Fig 1. Light microscopy images of spray dried particles. Length of scale bar: 100 µm.](image)

Surface morphology of the particles was evaluated using SEM (Fig 2):  

- Particles were spherical with no apparent cracks  
- Smooth and dented particles identified  
- 100% MD produced a larger proportion of smooth particles

![Fig 2. SEM images of spray dried particles. Length of scale bar: 200 or 300µm.](image)

### 3. Distribution of Components

The atomic composition of the surface layer of powder (~10 nm) was detected by XPS. The N atom is an indicative the presence of GA, as N was not detected in 100% MD. A surface enrichment of GA is observed in the powders, thus influencing the physical and microstructural properties of powders. This could be explained by surface active character of GA, which leads to its adsorption at the air-water interface during drying.

![Fig 3. Images acquired by FIB/SEM of hollow and solid particles.](image)

### Conclusions

1. The addition of GA significantly influenced the physical properties of the powder.
2. Particles of spray dried MD-GA were spherical shape without apparent breakage and the smooth surface were hollow.
3. The surface of the spray dried particle were dominated by GA as characterised using XPS.

### References


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**Gum Arabic as an Amphiphilic Functional Hydrocolloid in the Development of Encapsulated Air Microparticles**

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