3D Food Printing: effect of apricot pulp concentration on texture analysis profile and image analysis in a gel cylinder.

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Introduction

The World Health Organization (WHO), it is recommended to consume at least 400 g per day of fruits and vegetables for a healthy diet, but this average consumption is only two-thirds of the minimum recommended amounts of fruits and vegetables.
3D FOOD PRINTER

### Advantages
- Customization products
- Different shapes
- Use alternative sources
- Reduction of food waste

### Disadvantages
- Not all foods can be extruded raw

### Solution
- Addition other materials as hydrocolloids

- Vitamins
- Antioxidants
- Sugars
- Minerals
- Bioactive compounds

Protects against **CHRONIC DISEASES**
Objectives

Evaluate the effect of apricot pulp content on the printability and stability of bovine gelatin gels
Methodology
Methodology

Samples
- 5% Bovine Gelatin
- 30% apricot pulp
- 50% apricot pulp
- 70% apricot pulp

Analysis
- °Brix and pH
- Image Analysis
- Texture Profile Analysis

Shape Design
- Cylinder
  - 3 cm diameter
  - 1 cm height

3D Printer
- Nozzle diameter: 1.63 mm
- Nozzle speed: 20 mm/s
- Layer height: 1.63 mm
- Infill: 100% rectilinear
03 Results and Discussion
## Brix and pH

### Table 1.
Mean values (and standard deviations) of °Brix and pH of apricot gel.

<table>
<thead>
<tr>
<th>Sample</th>
<th>° Brix</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>AG30%</td>
<td>$8.7 \pm (0.2)^c$</td>
<td>$4.457 \pm (0.006)^a$</td>
</tr>
<tr>
<td>AG50%</td>
<td>$11.4 \pm (0.3)^b$</td>
<td>$4.21 (0.02)^b$</td>
</tr>
<tr>
<td>AG70%</td>
<td>$14.5 \pm (0.3)^a$</td>
<td>$4.013 \pm (0.006)^c$</td>
</tr>
</tbody>
</table>

* The letters (a-c= in columns indicate the homogeneous groups according to ANOVA (p < 0.05). (AP, apricot pulp; AG30%, apricot gel with 30% of apricot pulp; AG50%, apricot gel with 50% of apricot pulp; AG70%, apricot gel with 70% of apricot pulp).
Image Analysis

Figure 1. Deviations of the height parameter of the samples

- AG70% lower height deviation
- Higher shape stability
- Higher definition of the printing lines
Image Analysis

Figure 2. Deviations of the area parameter of the samples

No significant differences (p < 0.05)

Deviation of around 12%
## Image Analysis

<table>
<thead>
<tr>
<th>Sample</th>
<th>Top view</th>
<th>Side view</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>AG30%</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td>Less stable figure, low definition of print lines</td>
</tr>
<tr>
<td>AG50%</td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td></td>
</tr>
<tr>
<td>AG70%</td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td>Higher definition of the printing lines</td>
</tr>
</tbody>
</table>

**Figure 3.** 3D printed samples top and side view just after printing
### Texture Profile Analysis

#### Table 2. TPA test parameters.

<table>
<thead>
<tr>
<th>Sample</th>
<th>H (N)</th>
<th>A (N·s)</th>
<th>C</th>
<th>S</th>
<th>G (N)</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>AG30%</td>
<td>1.04 ± 0.09&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-0.45 ± 0.07&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.78 ± 0.02&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.878 ± 0.015&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.83 ± 0.06&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.46 ± 0.03&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>AG50%</td>
<td>1.39 ± 0.16&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-0.3876 ± 0.1016&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.758 ± 0.0018&lt;sup&gt;ba&lt;/sup&gt;</td>
<td>0.91 ± 0.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.06 ± 0.14&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.442 ± 0.016&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>AG70%</td>
<td>1.73 ± 0.15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.71 ± 0.16&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.74 ± 0.06&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.88 ± 0.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.2 ± 0.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.37 ± 0.03&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

* The letters (a-c= in columns indicate the homogeneous groups according to ANOVA (p < 0.05). (H, hardness; A, adhesiveness; C, cohesiveness; S, springiness; G, gummies; R, resilience; AG30%, apricot gel with 30% of apricot pulp; AG50%, apricot gel with 50% of apricot pulp; AG70%, apricot gel with 70% of apricot pulp).  

- AG70% needs the highest force to be deformed  
- AG50% presented a higher elasticity with respect to the rest.  
- AG70% and AG50% are the samples with the highest gumminess  

Increasing the AP content in the gels helps to maintain a better structure of the printed sample.
As the pulp concentration in the gels increased, the Brix and pH were similar to the apricot pulp values.

The samples with the least deviations concerning height were the AG70% samples, the ones with the best structural stability.

The higher the concentration of apricot pulp in the gelatin gels, the greater the increase in soluble solids content and therefore the greater the structural stability and firmness of the sample.
References

Thanks!

Do you have any questions?
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