Spray drying

Identification

Key words
powered juice, spray-dried, flavor instant food

Latest version
2010/12/20

Completed by
CENTIV

How does it work?

Primary objective
Dehydration-spray drying is a highly recommended process to obtain powders from sugar-rich foods such as fruit juices and extracts. Spray-drying is used for reconstitution purpose in drinks and released on a control basis. Spray-drying is the most common process to convert liquid to solid, and is one of the most complex methods for fruit juice drying. Fresh fruits are perishable and have limited shelf life. Sugar crystallization induction during drying through chemical substances or physical methods, may make the dehydrated powders more stable regarding to their functional properties. The objectives of drying of fruit and vegetable juices is to produce a stable and easily handled form of the juice, which reconstitutes rapidly to a quality product resembling the original juice.

Working principle
The transformation of juices into powdered particles implies a considerable reduction of volume and an effective method of prolonging shelf life. Besides is presenting an excellent reconstitution quality, since the products are difficultly submitted to temperatures above 100°C. Spray dryer uses hot air and can use fairly high air temperatures because the drying temperature drops drastically as water evaporates from the product being dried. The drying process can be completed within a short period of time, thus enabling to prepare dried fruit powder without heat degradation even at comparatively high air temperatures (Mani et al., 2002). The stickiness problems of sugar rich products such as fruit juices have been related to their low glass transition temperature (Tg). Some additives such as the starch, arabic gum, and maltodextrins are commonly used as the support materials to increase the Tg of the products during the spray-drying (Truong et al., 2005; Jaya and Das, 2004). Before being dehydrated, the juice is diluted in distilled water until reaching a total soluble solid content. Once the juice total solids are standardized, the carrier substances are added, e.g. Maltodextrin, Arabic Gum, Waxy Starch, etc. The solution is also treated with chemical substances, e.g. microcrystalline cellulose. Carriers utilized in juice dehydration also have an independent effect on the functional properties of the dehydrated material. Fruit and vegetable powders such as tomato, spinach, blackcurrant, apricot, raspberry, passion fruits, mango, EUGENIA PYRIFORMIS and pineapple have been produced using spray drying (Abadio, et al., 2004; Goula, et al., 2004). Dried fruit and vegetable powders have been used to enhance color, flavor, water-binding capacity, and nutritional benefits of various food products (Francis and Phelps, 2003).

Images
Additional effects
One of the major problems in spray drying of fruit juices is stickiness of fruit powders on the dryer walls during drying. It is important to determine the influence of carriers and the addition of chemical substance on the microstructure and correlate them with the functional properties stickiness and solubility. The great advantage of this technique is the storage stability of the product.

Important process parameters
The drying parameters are: input temperature = 160°C; output temperature = 74°C; atomizer air flow = 700 NL/h; feed flow = 20mL/min and feed temperature = 30°C remaining fixed during the experiment. The material obtained is stored in commercial bags (laminated sheet of approximately 100 g), which was stored in a desiccator containing silica gel until posterior utilization.

Important product parameters
Fruit juice is very sensitive and affected the different drying parameters. Drying parameters are required to be optimized for each juice. The parameters should be tested and determined before the design of the dryers, and include: drying agent material, feed flow rate inlet and outlet air temperature and sticky point temperature.
In general, the powder is obtained by means of mini spray drying, with the flow of air drying parallel to the material feeding.

What can it be used for?

| Products             | Fruit and vegetable juices  
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Dried juice product, dried fruit powders</td>
</tr>
</tbody>
</table>

Operations
Drying is the major food processing operation to increase the shelf life.

Solutions for shortcomings
Spray drying is one of the most complex methods for fruit juice drying. Fruit juice is very sensitive and affected the different drying parameters. These powders are very hygroscopic materials what make them very susceptible to the functional property of stickiness. A high sugar content solution, when spray dried, yields products with a high degree of amorphous sugars.
This data sheet describes how to overcome this problem by using special carriers.

What can it NOT be used for?

<table>
<thead>
<tr>
<th>Products</th>
<th>The limited methods have for production of fruit powder without aided drying materials. Natural hygroscopic and thermoplastic property of fruit juice is the basis problem in transport and handling of fruit juice powder produced in spray.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations</td>
<td>The parameters of inlet air temperature and feed flow rate have significant effect on the dryer yield and wall deposit of spray dryer individually and jointly. Stickiness is related to the material property.</td>
</tr>
<tr>
<td>Other limitations</td>
<td>The fruit juice powders obtained by spray drying present problems in their functional properties stickiness and solubility, making their packaging and utilization substantially difficult. Bhandari et al. considered that these problems are due to the fact that the materials have high contents of low molecular weight sugar (such as fructose, glucose and sucrose) and make drying difficult. Is necessary to correlate the stickiness property with the Tg, drying parameters, drying kinetics, evolution of surface property of droplets</td>
</tr>
<tr>
<td>Risks or hazards</td>
<td>Not known</td>
</tr>
</tbody>
</table>
**Implementation**

**Maturity**
Already used, available from lab to industrial scale.
Fruit juice spray drying has great economic potential.

**Modularity**
Technology is based only on additive of carriers into the juice before spraying. There can be added an additional mixed vessel before spray dryer.

**Implementation**
Stickiness of fruit powders can be reduced by adding higher Tg components to the fruit juices and by modifying the spray-drying chamber with rotating air broom system. As examples: An addition of 45% maltodextrin to mango juice produces free flowing powders at the dryer outlet. Modified spray dryer with rotating air broom system reduced the stickiness problem by 30% to produce banana powders. (Mani et al., 2002).

**Consumer aspects**
No negative effects

**Legal aspects**
Not known

**Environmental aspects**
Not known

**Facilities that might be interesting for you**

<table>
<thead>
<tr>
<th>Title</th>
<th>Institute/company</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-290- Mini spray dryer-HES-SO Valais-HEI</td>
<td>University of Applied Sciences and Arts Western Switzerland Valais</td>
</tr>
<tr>
<td>GPCG1-Fluidized bed dryer-HES-SO Valais-HEI</td>
<td>University of Applied Sciences and Arts Western Switzerland Valais</td>
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<tr>
<td>IRTAsim</td>
<td>IRTA</td>
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<tr>
<td>MP41/60, Zs240- Drum dryer- HES-SO Valais-HEI</td>
<td>HES-SO Valais-HEI</td>
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<tr>
<td>Microwave vacuum drying pilot system KEKI</td>
<td>NAIK EKI</td>
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<td>QDS system IRTA</td>
<td>IRTA</td>
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<tr>
<td>Spray Dryer - TTZ</td>
<td>TTZ</td>
</tr>
<tr>
<td>Spray dryer - HES-SO Valais-HEI</td>
<td>University of Applied Sciences and Arts Western Switzerland Valais</td>
</tr>
</tbody>
</table>

**Further Information**

**Institutes**
The University of Queensland, FRIP, University Paris-Sud

**Companies**
Glatt, GEA Niro, Büchi, Nestlé Research Centre, INRA - GENIAL, AgroParisTech, CENTIV, Nisco
References