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Temperature Influence on Drying Time by Spray Drying Process in Strawberry Powder Production

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ABSTRACT:
The method of spray drying reduces handling and preserves the product by lowering water activity to a low level and halting bacterial decomposition. In the drying process of a spray dryer, by adding a certain solvent a spray of liquid is brought into contact with a heating gas to vaporize the water. The present study aims to analyze the affects of temperature on the drying time of strawberry extract powder in a spray dryer. Maltodextrin 10% is added to strawberry solution beforedrying. The drying process was then completed with a Spray Dryer under varied inlet temperature(120^oC, 130^oC, 140^oC, 150^oC and 160^oC). The result is higher drying temperatures and bigger temperature differences between the material and the heating source lead to faster heat transfer, which accelerates the drying process by causing more water to evaporate. The ideal temperature is reached at 160°C, and drying takes 754 seconds at that temperature as well as 951 seconds at 150°C.

Keywords*: heating, drying time, powder, spray dryer, strawberry*

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I. INTRODUCTION

Drying of a wet solid is the separation of a small amount of water or liquid from a material thereby reducing the residual liquid content in the solid to an acceptable low value [1,2]. Drying is usually the last step in a series of operations and the dried product is usually ready for packaging [3,4,5,]. The types of drying that are widely used include sun drying, atmospheric drying (solar drying, cabinet drying, tunnel drying, conveyor drying, drum drying, spray drying), and sub-atmospheric drying (vacuum drying, freeze drying) [6,7,8]. The most used drying technique in business, particularly the food industry, is spray drying, which is used to dry items that are ultimately converted to powder [9,10]. With the help of this technique, extract powder can be created from substances like flavored milk products [11,12,13].

Spray drying is one of the first and most popular encapsulation methods in the food industry. About 80–90% of the materials are spray-dried capsules. It is the technique that is most frequently used to encapsulate polyphenols from fruits. Spray drying is a useful technique because it is inexpensive, versatile, delivers high-quality products with high yields and stability, and is suitable for both thermolabile and heat-resistant materials, according to Shi et al. [14].

The phenolic substances anthocyanins, phenolic acids, flavanols, and ellagitannins are abundant in strawberries [15,16,]. Strawberries are an organic fruit that, according to published research, is often distinguished by a high level of bioactive compounds. The Rosaceae family of plants includes strawberries, which are prized for their distinct flavor and vibrant red color. They contain a lot of bioactive substances that have antioxidant and anticancer properties. Strawberries are a seasonal delicacy that is perishable, very mechanically vulnerable, and readily spoilable.After harvesting, it's critical to process them as soon as possible using the proper technological activities. They are either frozen or processed into a variety of intermediary goods or dishes. One of the key subgroups of processing methods is drying processes.

Several studies on the spray-dried components that are isolated from fruits and capsuled in some literature [17, 18]. In order to dry a material using a spray-drying equipment, all of the liquid must first be atomized (or reduced to tiny water droplets) using an atomizer. The mist-shaped substance's liquid is then in touch with heated air. This contact occurrence causes the misty liquid to dry and transform into powder. Additionally, a cyclone or filter is used to separate the hot steam from the flour or powder. Following separation, the flour/powder temperature is further decreased in accordance with production demands. To acquire dried goods, the spray drying technique is most frequently utilized, and it has grown in popularity in recent years.Maltodextrin, an ingredient, is used to create the dried product, which is 60% powder in comparison to the juice.

Review of spray drying method were discussed [19,20]. It examines experimental studies on the factors that affect particle production. Provided a classification based on dimensionless numbers that may be used to predict how the morphology of manufactured particles is affected by excipient qualities in conjunction with process variables. Low density particles, composite particles, microencapsulation, and glass stabilization are just a few examples of pharmaceutical application examples that are covered in detail, with a focus on the underlying mechanics and design principles of particle creation. Many various methods were developed by the researchers to produce strawberry flour.

Physicochemical properties of microencapsulation strawberry juice with maltodextrin effect was provided by Sadowska et al.,[21]. Organic strawberry powders produced by convective drying, freeze drying, and spray drying were compared in terms of quality. In the study, several kinds of analysisthe determination of the physicochemical qualities, the concentration of vitamin C and polyphenols by liquid chromatography, antioxidant activity microstructure using a scanning microscope, and sensory quality by profile method. Smoothness and uniformity of appearance were equally scored for the freeze drying, and spray drying powders, with strawberry flavor being the most advantageous for the freeze drying powders.

During the spray-drying of strawberry puree, the performance of two drying agents—whey protein isolate (WPI) and maltodextrin—was assessed. The surface tension of strawberry puree reduced and powder recovery rose when WPI replacement in the feed material increased. The surface morphology of powders revealed that the addition of WPI caused the particle surface to contract, resulting in a reduction in particle size. Even with the addition of 0.5% WPI, the particle morphology was changed since the particles were not spherical. With an increase in WPI from 0.5% to 10%, strawberry powder's surface shrinking got worse. When maltodextrin is swapped out with 1% WPI, strawberry powder production efficiency can be significantly increased.From previous review,the present study aims to experimentally analyze the affects of temperature on the drying time of strawberry extract powder in a spray dryer.

II. EXPERIMENTAL SETUP

There are two key components: maltodextrin, which serves as a carrier/filler, and liquid base, which serves as the fundamental flavor to be processed [22]. Adding water into the mixer tank, which has a jacket, in the initial stage. The mixture is then heated to a temperature of around 50–60^{o}C, at which point the powder is added and stirred for 30–60 minutes. The mixture is then cooled until the temperature is 30^{o}C. Nitrogen is injected to the Mixer Tank to remove the foam that the stirring operation will produce on the surface because foam can make the spray drying process less effective.Before mixing Liquid Base, do the cooling process to a temperature of 15^{o}C. After adding Liquid Base, emulsifying is carried out for 15-30 minutes depending on the Liquid Base used. Take a sample to check the particle size (0.7-0.8 micron). After the particle size falls within that range, the mixture is ready to be sprayed. Prepare the material, then adjust the temperature and flow rate of the drying air into the spray dryer column according to the variable, namely the drying air temperature (120^{o}C, 130^{o}C, 140^{o}C, 150^{o}Cand 160^{o}C), wait until the humidity is constant. After that, set the nozzle spray dryer and compressor. Then put the feed that has been heated at 80°C in the spray dryer. Collect the powder obtained and then analyze the water content, efficiency and product characteristics.The volume of the feed that is applied to the tool is 500 mL. The maltodextrin carrier was added to strawberry juice to create the spray dried powders, which were then produced at air temperatures of 160°C for the inlets and 90°C for the outlets while using a dispersing nozzle with a diameter of 0.7 mm (B290-Mini Spray Dryer, BüchiFlawil, Switzerland).

III. RESULTS AND DISCUSSION

The following working parameters were taken into account for the current experimental work: drying time versus temperature.According to Table 1, a rise in temperature causes the drying process to speed up. This is due to a rise in salt temperature, which leads to higher water evaporation and an increase in the flow rate of strawberry mass, both of which enhance productivity. Table 1 demonstrates that at 160°C, the best performance occurs in 754 seconds (12 minutes 34 seconds). The drying time is also very quick at 150°C, taking only 951 seconds (15 minutes 51 seconds).Drying at an initial temperature of 120°C and 130°C had a long drying time of 976 seconds (16 minutes 16 seconds) and 951 seconds (15 minutes 51 seconds). The higher the drying air temperature, the faster the steam is taken from the material,hastening the drying process. The assertion made by Quek et al.[23] that the greater the temperature differential between the heating medium and the material, the quicker heat will be transferred to the strawberryand the quicker water will evaporate from it, supports the study's findings. In this manner, it can be shown that the faster the material dries, the greater the temperature being employed.

Table 1. Temperature versus drying time

No.	Tinlet(°C)	Drying Time (s)
1	120	976
2	130	951
3	140	886
4	150	823
5	160	754

According to Gong et al.[24] higher drying air temperatures and greater temperature differences between the heating medium and the material result in faster heat transfer, which causes more water to evaporate and speeds up the drying process. Since more heat energy is transferred into the air at higher drying air temperatures, mass transfer happens more quickly.Then it was also reinforced by Can et al. [25] that the higher the drying air temperature, the greater the temperature difference between the heating medium and the material, the faster the heat transfer occurs so that more water is evaporated and the drying speed is faster. The higher the drying air temperature, the greater the heat energy that is carried into the air so that the faster the mass transfer occurs [26, 27]. Temperature and air-drying air-speed increases will boost product efficiency. This occurs because of changes in liquid vapor pressure, which, at the same temperature as the drying air speed increases, increases product efficiency. The temperature and high air velocity will speed up the evaporation process on the surface and inside of the particles [28, 29, 30]. The water content of the strawberry extract samples was the only parameter that significantly changed as a result of the temperature rise; all other parameters remained same.

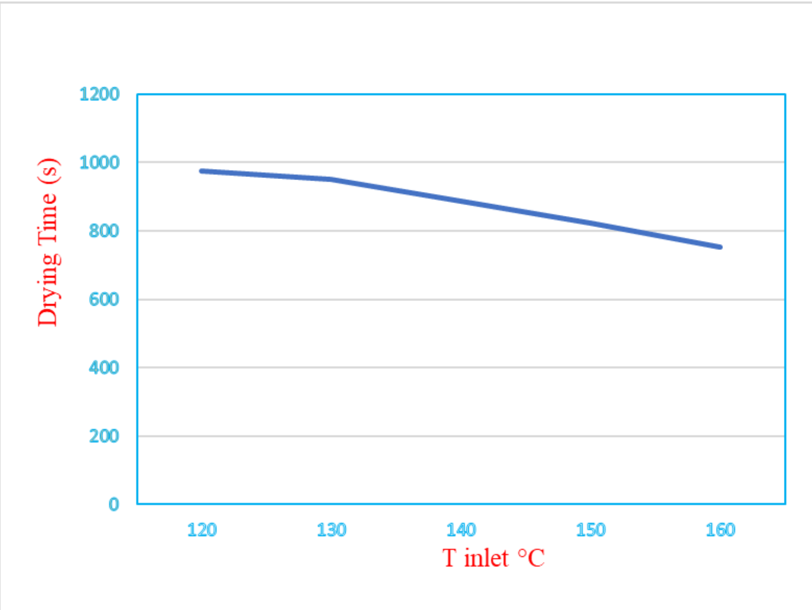

Fig. 1 Temperature against drying time

IV. CONCLUSION

Spray drying is a well-researched drying method used for a variety of food, including strawberry extract powder. The following list might be used to succinctly organize the important concluding items:

1. Thehigher drying air temperatures and greater temperature differences between the heating medium and the material result in faster heat transfer, which causes more water to evaporate and speeds up the drying process.
2. The optimum temperature occurs at 160°C and drying time is 754 seconds, and also at 150°C in 951 seconds.

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