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ANALYZING THE IMPACT OF SPRAY-DRYING PARAMETERS ON THE MICROCAPSULES OF BIOACTIVE INGREDIENTS AND PHYSICOCHEMICAL PROPERTIES OF STRAWBERRY JUICE POWDERS

Abstract. The original fruit flavour is preserved while the volume is reduced and the juice is easily handled in powder form. Therefore, we looked at how spray drying conditions affected the physical and bioactive properties of pomegranate juice (SJ) using sugar (MX) as a transport agent. Low levels of MX led to increased levels of phenolics & antioxidant activity, whereas drying temperature had no effect. The testing takes place in the DKT Lab, where it has been found that the juice is good low – molecular – weight carbohydrates slowed the glass transition temperature (Tg). Scanning electron microscopy (SEM) analysis showed that the particles aggregated at low MX doses but were successfully separated at intermediate and high MX values. Because of this amorphous form, X-ray diffracts (XRD) microstructural analysis revealed that all samples were viable candidates for microencapsulation of bioactive compounds for long-term storage and stability.

Keywords: maltodextrin, total phenolic content, thermal characterization, and as a transporting agent.

1. Introduction

Strawberries, or Fragaria x ananassa Duch., are a popular fruit due to its sweet taste, vibrant red colour, and distinctive aroma. In 2019, China produced 35.7% of the world's strawberries, followed by the USA with 11.2% and Mexico with 10.1%. Many people believe that strawberries deserve their great popularity because of the health benefits they provide. Raw and prepared versions of these fruits are both consumed often. Strawberries have a wide range of phytochemicals includes polyphenols, sugars, phenolic compounds, vitamin C, including flavonoids such anthocyanins, tannins, or flavonols. Common flavonols found within strawberry fruit include quercetin and its derivatives, and common ellagitannins include free catechins and its derivatives (Huntington D. [1]).

These flavonols or ellagitannins are found in phenolic compounds that are renowned for their antioxidative activity potential and their crucial function in protecting plants from biotic and abiotic stress. It is these anthocyanins that give strawberry fruit its distinctive hue. The degradation of helping people lipoproteins may be effectively blocked by eating strawberries because of their strong scavenging capacity against chemically produced radicals. Strawberries' antioxidant properties may aid in the fight against cancer, heart disease, and other degenerative conditions (Huntington D. [1]).

Despite being delicate and often ruined due to mechanical damage, strawberry harvesting occurs only during specific times of the year. Multiple industrial methods have been used to improve the fruit is shelf life. Techniques such as drying, intermediate product preparation, and fruit freezing all belong here. Dried fruits can be used to make a wide variety of products, from meal concentrates and desserts to fruity drinks, hair care products, and dietary supplements. Utilizing transporting ions in the drying process is a fast and dependable approach for reducing the water content of beverages, increasing their stability, and lengthening their shelf life. This method involves coating or enclosing biological molecules and temperature-sensitive chemicals in a carrier agent to shield them from environmental factors and oxidation.

Spray-drying dried strawberry puree was used to test the efficiency of two desiccants, whey isolates (WPI) & maltodextrin (MD). Powder recovery and strawberry puree surface tension both improved when WPI was substituted at higher rates in the feed material. Powder recovery (Rp) increased from 39.2 2.3% (S: Dm: G/g = 60:40:0) and 56.5 2.8% (S: Maryland: WPI = 60:39:0) when Component was replaced with WPI.. The powders' surface morphology, when WPI was added, demonstrated that the particles' surfaces shrank, which in turn caused the DB or particle size to decrease. Even with introduction od 0.5% WPI, the particles' morphology deviated from the ideal spherical shape. Increasing the strawberry powder's WPI from 5% to 10% caused the powder's surface to decrease. When 1 percent WPI is used in lieu of MD, strawberry powder manufacturing efficiency is considerably increased.

However, Input temperature, feed flow, and transportation agent concentration are three variables that may affect the final physicochemical characteristics of the drying. The optimal spray drying settings for blueberry juice were investigated by et al. (2019) by taking into account a variety of factors. According to their findings, the maximum yield or contents of 3-D-galactoside were achieved at a process temperature of 210 C and a content of 25% maltodextrin (MX). Broccoli juice's antioxidants were recently examined in a drying conditions study conducted by Saavedra-Leos al al. 2021 [10]. Both total flavonoid content (TPC) & antioxidant properties (AA) were maximised at 5% MX and 220 C intake temperature. Maltodextrins, which are high-molecular-weight additives, have been used in these studies to raise the product's glass transition temperature.

While insulin, protein powder isolate, or arabic gum have all been utilised as carriers in the dehydration of fruit juices, MX has shown particularly strong performance with regard to the preservation of antioxidants. Few works have documented drying of cranberry juice (SJ) or purée. Strawberry juice powders generated by various drying techniques were studied by Sadowska et al., who reported on their bioactive, physicochemical, sensory, and microstructural features. Spray drying (SD) using a 60% maltodextrin concentration as a drying aid is one technique used. But Gong et al. Used a statistical technique called sum of squares to see what happened when strawberry pure (S) was mixed with whey isolates (WPI) and magnesium xitolate (MX) (SD). Uses of S were at 60%, MX at 40%, and WPI at 0–10%. Physically and stable powders were reported to result (Roos Y. [2]).

It appears that a high concentration of the transportation agent was employed in both processes, which may have an adverse effect on the quality of the finished product. Low carrier chemical levels and moderate drying temperatures are recommended for testing. The goal of this research is to perfect a low-input-temperature (150, 185, or 220 C) and low-MX-concentration drying process for cranberry juice (SJ) (5 percent, 7.5 percent, and 10 percent). To measure how well the bioactive components were packaged in the microcapsules, The phenolic content (TPC) or antioxidant capacity of these foods were analysed (AA). Also covered were aspects such as the powders' thermal, morphological, or microstructural characteristics.

This study lays the framework for a novel spray-drying technique for heat-sensitive substances like fruit juices, sugar-rich solutions, and other similar products.

2. Literature Review

Drying is a common and reliable technique for reducing a variety of liquid food ingredients to powder form. Among the benefits is a continuous process that allows for low costs and high yields of high-quality powder. However, stickiness is common when low-molecular-weight carbohydrates like fructose, glucose, et sucrose are used in the manufacturing process. Glass transition temperature is largely responsible for sugars' stickiness (Tg). The Tg of sugar, glucose, and sucrose, for instance, are 16, 31, and 62 degrees Celsius. Spray drying is not widely used because of the logistical difficulties and financial losses caused by sticky materials. Incorporating drying aids like maltodextrins, starch, and low-moisture air through mechanically exfoliating the drying wall, and other options are all viable solutions to the stickiness issue; however, adding maltodextrins is the most practical. Increased Tg from the elevated maltodextrin (MD) eliminates stickiness while decreasing hygroscopicity. Concentrated fruit juices can be converted, but only with the use of high amounts of drying chemicals like MD (>40 percent). High concentrations of drying chemicals have the potential to affect the original product's flavour, taste, and colour. Adding a little protein to the droplets or particles is another unique method for reducing stickiness. Sticky gunk of sugar-protein solutions may be addressed by the preferential movement of proteins in conjunction with dry film formation. Powder recoveries were often greater when dairy proteins were used instead of plant proteins.

Due to their strong antioxidant activity of their polyphenols, strawberries (Fragaria x principle allows Duch.) are among the most popular and lucrative fruits inside the Chinese market. Strawberries are an extremely perishable fruit, so when they go bad, businesses lose a lot of money. Spray drying may be a viable technique for drying strawberries high in polyphenols, a group of antioxidants that are destroyed by heat. Phenolic content plus total anthocyanins were retained at around 96% and 94%, respectively, after the spray drying process, according to a study by Fang et al. [5].

In particular, the anthocyanidins that give strawberries their vibrant hues are known to have preventive effects against inflammation and cardiovascular disease. Observational studies suggest to correlate frequent berry eating with fewer heart-related fatalities. When consumed with a carb heavy meal, strawberries seem to reduce the body's need for insulin and decrease the digestion of glucose. According to research, the anthocyanins are responsible for this phenomenon.

There are defensive plant components in strawberries called polyphenols, and two of these compounds, ellagic acid and ellagitannins, have showed promise in alleviating some of the symptoms of type 2 diabetes. They seem to be especially effective in controlling blood sugar and blood pressure. More study is required to confirm these effects in people (Roos Y. [2]).

Studies show consuming strawberries may prevent some malignancies. The preventive effect is considered to be attributable to a mixture of polyphenols like ellagic acid or ellagitannins, which seem to inhibit the development of cancer in animal experiments. More animal studies are required to identify the proper route of activity and to validate the results.

Strawberries have a lower glycemic index (GI) and therefore assist control blood sugar release. Studies show that a diet with abundance of low GI items may be advantageous for weight control and for lowering the occurrence of obesity-related disorders. Strawberries are very low in calories, although sweet tasting thus may be good as a sweet fix.

While most of us can eat strawberry without a difficulty, they are a frequent allergy, particularly for young children. If you have sensitivities to birch dust or apples, then are more prone to developing a second food allergy towards strawberries. In case it makes a difference, you should stay away from strawberries.

As a bonus, strawberries' antioxidants may protect against cataracts, a condition that may cause blindness in later life. Because free radicals from the sun's UV rays may destroy the protein inside the lens, vitamin C is necessary for eye health. The cornea and retina benefit greatly from vitamin C's ability to promote tissue health. (Here are some more options for maintaining good eye health.) Scientists at the Salk Institute in Stockholm found that women over the age of 65 who consumed large amounts of vitamin C supplements had a higher risk of developing cataracts, but that this effect did not hold true for women who consumed vitamin C naturally from foods like fruits and vegetables.

Salicylates are naturally occurring compounds found in many fruits, including strawberries, apples, peaches, avocados, and blueberries. Some persons may have an allergic response to these chemicals, manifesting as a rash and/or swelling of the skin. For people who have a thyroid issue, limiting the consumption of strawberries is recommended since they contain goitrogens, substances that may disrupt thyroid function (Roos Y. [2]).

The high proportion of low-molecular-weight carbohydrates in strawberry fruits may contribute to their stickiness during spray drying. If you combine protein with maltodextrin as a drying carrier agent, you can try spray drying strawberry puree, which may help solve this problem. In order to find a solution to the sticky residue that is left after spray drying strawberry puree, this study aimed to see if a combination of sorbitol (MD) and soy protein isolate (WPI) could help. We also looked into the melting point index (Tm), the microstructure of the dried strawberry powder, and the physicochemical parameters of the feed solution to see how water activity affected the spray drying process. Second, we aim to determine if the inclusion of a negligibly small amount of proteins is sufficient to restrict the formation of MD in spray-dried strawberry powder.

Powders made from spray-dried strawberries had their physicochemical properties examined. This included things like the powder's recovery rate, its moisture content, its aw, Tg, and its microstructure (Bhandari B. [3]).

3. Methods and Materials

3.1 Materials

These Mei 13 cultivar frozen strawberries were produced by Laiyang Jia and the Er Meal Ltd. (Jinan, China). China's Hangzhou Puxiu Bio Technologies Co., Ltd. and the United States' Hilmar Cheese Co. supplied the protein-rich milk isolates (WPI 90) and the sorbitol with a dextrose equivalent (Dm of DE10), respectively (California, USA).

3.2 Sprayed-Powder Manufacturing (With the help of Buchi Spray Dryer)

In DKT lab, to create powdered strawberry juice (SJ), a Buchi spray dryer was used. The spray-drying conditions suggested by Rodriguez et al. were modified somewhat. To prepare the feeding solutions, just mix the necessary amount of MX into 200 mL of SJ. Using a Mini Drying B290 (BÜCHI, Forerunner for the biosynthesis AG, Flawil, Switzerland), we were able to microencapsulate at a feed temperature in the range C, a feeding flow of 7 cm^3/min, a hot flow = = 28 m^3/h, a suction rate of 70%, as well as a pressures of 1.5 bar. The intake temperature of 150, 185, and 220 degrees Celsius were tested, for instance.

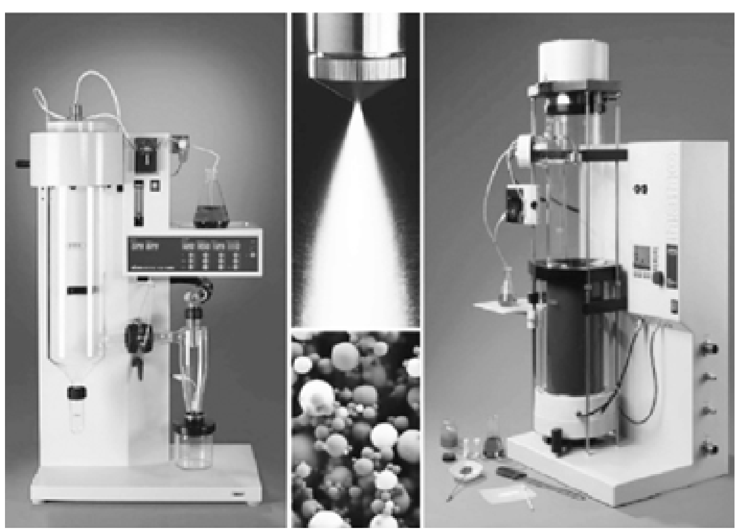

Figure 1. For Buchi Spray Dryer

This broad temperature range was chosen to prevent the particles from becoming sticky or clumping together, both of which would lead to a collapse of the microstructure. Amounts of the material and process were recorded and stored by label. The powders were kept in sealed containers at 4 degrees Celsius in a dark environment. Experimental strategies used to dehydrate SJ-MX blends.

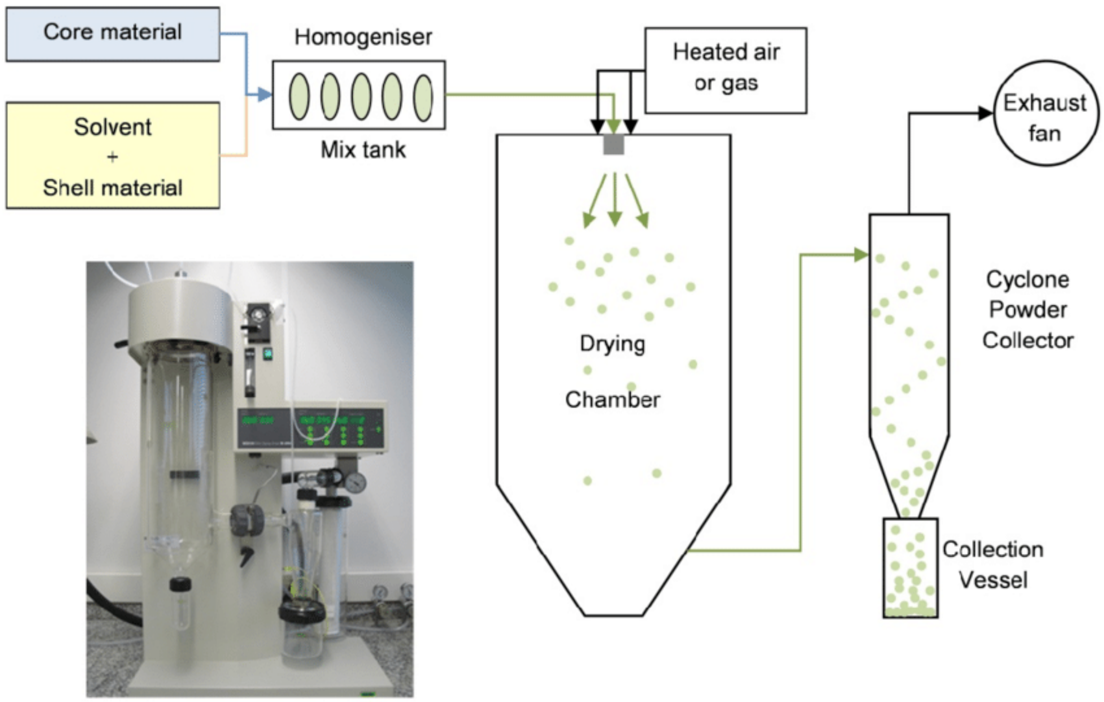

Figure 2. Schematic Diagram of the Process

3.3 SJ-MX Powder Bioactive Compound Extraction

The following procedures were carried out in order to obtain the powdered extractor of strawberry juice: One gramme of SJ-MX powder was dissolved in three ml of water. Once everything was dissolved, 7 mL of esters was added. The extraction process took an hour during which time the mixture was regularly stirred. Once the incubation period had ended, the mixture was centrifuged for fifteen minutes at 11,000 spinning at 4 C, and likewise the ensuing mixture was filtered and 37o C opaque orange bottles to minimise damage due to light. Thereafter, the supernatant was centrifuged, filtered, and resuspended. the precipitate was reconstituted in 70% methanol and agitated for 1 hour. There are two different extracts.

Table 3. – Physicochemical characteristics of organic strawberry fruit dried by Buchi Spray Dryer methods

Type of Drying	Dry Mass (g kg^{-1})	Water Activity	pH	WHC(gH_2Ogd.m.$^{-1}$ of Powder)	WSI(gkg^{-1})
FD	978.2 ± 0.3^{c}	0.10 ± 0.001^{a}	3.54 ± 0.01	2.81 ± 0.21^{c}	619.1 ±3.3^{b}
CD	962.5 ± 3.2^{a}	0.27 ± 0.002^{b}	3.58 ± 0.02	2.36 ± 0.14^{b}	549.8 ± 3.4^{a}
SD	968.6 ± 2.5^{b}	0.28 ±0.005^{b}	3.57 ± 0.02	1.05 ± 0.11^{a}	885.4 ±4.6^{c}
Raw	915.5 ± 5.3^{d}	0.98 ±0.005^{c}	3.56 ±0.02	–	–

a–d: values marked by different letters significantly ($p< 0.05$); FD: freeze drying, CD: convective drying, SD: spray dryin

3.4.1. Finding the Total Phenolic Content

The total phenolic content content (TPC) of the extracts was calculated using Dtnb, with gallic acid serving as the primary standard. I used 0.1 mL of a concentrated extract and 0.1 mL of water for the reaction (1 N) With the aid of a reagent, 0.1 ml of a Sodium carbonate solution (7.5% concentration) and 2.8 mL of water are used. This light absorption was studied by focusing on a certain wavelength (750 nm). The TPC was reported as phenolic acids (Tannic acid equivalents) per g dry SJ-MX.

3.4.2. DPPH-Induced Changes in Antioxidant Activity

The extract samples' ability to either donate hydrogen to the system or scavenge radicals was evaluated by analysing their ability to react with the stable Dpph. The volume of extract used in the reaction was 100 L, while 3.9 mL of Total phenolics was added. We compared the absorption of the reaction medium to a calibration solution at 515 nm, using a sample of pure methanol as a reference. After calculating with a Trolox calibration solution, the results were represented as the mols of trolox equivalents per g dry powder juice (mol TE/g SJ-MX).

3.5. Thermographic Examination

3.5.1. MDSC

With only an RCS90 chiller, the phase transformation temperature was measured with a Myeloid Q200 (TA Measures, Castle, DE, USA) (Tg). The crystallization and volatility were calibrated with indium, whereas the heat capacity is calibrated on sapphire (Cp) (Cp).

Totaling 10 mg, In Tzero® aluminium trays, samples were stored and transported (TA Instruments, New Castle, DE, USA). To create these thermograms, we used a 40-second modulation duration and a temperature amplitude of 1.5 degrees Celsius. It was necessary to repeat each experiment three times to ensure accuracy (Bhandari, B. [3]).

3.5.2. TGA-DSC-SDT

TGA and DSC studies were carried out simultaneously using a TGA-DSC SDT Q600 (TA Technologies, New Wilmington, Ca, USA) in this investigation (TA Instruments, New Castle, DE, USA).

The melting point and enthalpy of indium were used to calibrate the DSC (potential change of °C and gonna melt possibility of 28.47 J/g). Standard aluminium baking plates were used to encapsulate ten milligramme samples. With the help of the Universal Analysis 2000 programme, thermograms were obtained while gradually increasing the temperature from 25 degrees to 400 degrees.

3.6. A Physicochemical Description

3.6.1. Electronic Microscopy Scanning

When describing morphology, we used a scanning electron microscope (SEM; JEOL JSM-7401F) operating at 2 kv. As a first step, powder was evenly distributed on graphite conductive tape, and then gold nanoparticles were sputtered on top to neutralize any potential charge effects (Denton Desk II sputter coater, Dillon, TX, Us) (Denton Desk II sputter coater, Denton, TX, USA).

3.7 Surface tension (ST)

Partial pressure of strawberry puree was measured using a QBZY-2 interfacial tension meter (上海 FangRui Instruments Co., China) prior to spray drying (Shanghai FangRui Instrument Co., China) [5]. A test container was filled with sample solutions, and then a gold Wilhelmy slab was slowly lowered into and raised from the liquids. The surface tension was additionally measured by the programme. For each sample, the analysis was performed five times.

Powder recovery

Spray-dried solids mass divided by feed solution dry mass yields the powder recovery percentage. This is dry matter, or DM.

3.8 Water activity and relative humidity (aw)

Gravimetric analysis (GB/T5009.3–2003) was used to ascertain the relative humidity. After being triple-weighed, the strawberries were ground into a powder and dried in an oven oven at 105 degrees C for 12 hours. We utilised a Water Activity Meter to find out how lively the water was (Model CR-400, Konika Minolta Sensing, and Japan). Three separate lab runs were performed on the samples, from which an average was generated.

3.9 Particle size distribution and bulk density (DB)

To use a measuring cylinder with 50 mL size and a scale, we measured the densities of a powdered with a weight of 2 g by dividing the mass of the material of the cylinder.. Each sample was subjected to five different analyses. A laser particle size analyzer was used to quantify particle volume and mean size (Dandong Better dimension Equipment Ltd., Liaoning, China). We macerated a small sample to confirm that the nanoparticles were thoroughly mixed. The pressurized air itself served as the transmission medium. We took particle size and dispersion into account in every experiment. Where D is the mean diameter of a sphere with the same volume, D is a nonlinear fit of particle size.

We used a chilled TA Q_{20} dsc thermometers (TA Instrument, Castle, Delaware, USA) to measure the Tg of the berry powder, MD, and WPI. The DSC steel pan was filled and sealed with particles after they were preweighed to be 10 mg; a second, empty pan served as a reference. Each run began with samples being cooled in liquid nitrogen. Each powder was heated from ambient temperature to the one hundred degrees Celsius in a nitrogen environment at a pace of twenty degrees Celsius per minute. Using DSC, we was able to measure the rate of heat transfer and hence calculate Tg. Using Universal Analysis, we calculated the Tg ratios (TA Instruments, New Castle, USA).

3.10 Statistical Analysis

An FEI SEM was used to examine the surface morphologies (SEM, FEI Co., Oregon State, USA). The 5,000x magnification photomicrographs were taken at ambient temperature.

Duncan's test one and volatility analyses (Anova (ANOVA)) in Cps 18.0 were used to see if the discrepancies between the powders were statistical significance. When the data were analysed, a p value of 0.05 was taken to signify statistical significance (mean standard deviation).

4. Results and Discussion

4.1. Indicators of Antioxidant Power and Total Phenolic Content

The TPC in Figure was made using powdered paint strawberry beverage (SJ-MX) made with different input temps and Sx concentrations. TPC is expressed as the amount of tannic acid in acid equivalents (gae (GAE) per kilogram of dried SJ-MX. Findings showed that there was a statistically significant (p 0.05) inverse relationship between MX concentration and TPC.

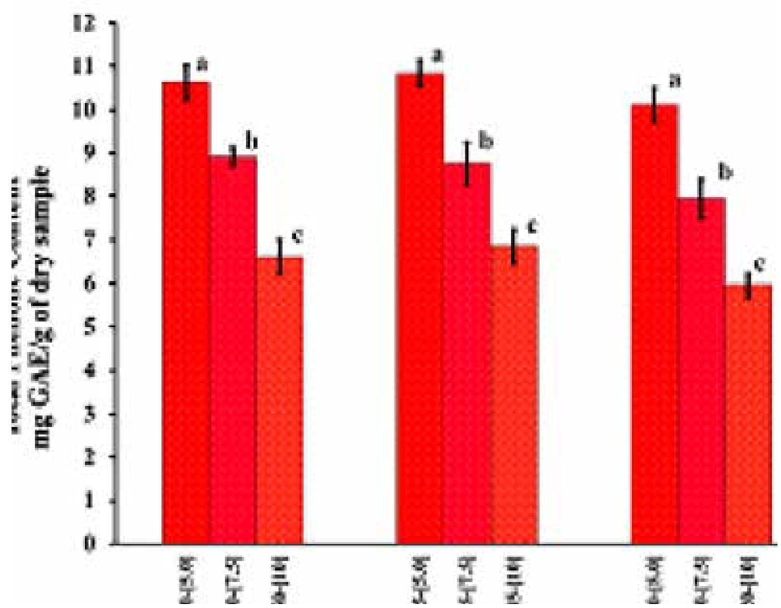

Figure 4. Total Phenolic Content of Strawberry particles

The highest TPC values were achieved while using 5% MX (10.8 0.19 mg Gallic acid equivalent wet sample). The lowest MX content was associated with low TPC values (5.9 factors may increase mg dried sample) (10 percent). On the other hand, for a given amount of MX and a range of input temperatures, When comparing the TPC of different SJ-MX powders, no statistically significant changes can be found ($p = 0.05$). TPC experiments, for example, reported between 10.1 and 9.6 mg GAE/g dry material at temperatures between 150 and 220 °C and 5 percent MX content (Bhandari, B. [3]).

4.2 Susceptibility to feed solution surface tension

Surface tension values after spray drying vary as a function of the Blueberry: Dr. Lawrence: G / g (S: MD: WPI) ratio in the feed solutions, as depicted in the figure. The ST value was calculated to be 33.6 0.4 mM 1 with a S: MD: Consumer price index (cpi ratio of 60:40:0. Significantly lower ST values in the feed solution were observed when WPI were present (p 0.05). (S: MD: WPI, 60:40:0). The ST measurements of the feedwater declined drastically when the Version 2 was raised to 1%. However, the ST values did not change noticeably when the WPI proportion was increased from 1% to 10%. The results showed that adding sugar to the strawberries puree (range: 33.2–33.8 mM m1) did not alter the surface energy of the mixture. As an alternative, WPI drastically reduced ST in strawberry purees. WPI contains surface-active compounds that preferentially migrate to the air/water interface and lower a solution's solubility threshold. Furthermore, the results indicated that the air/water interface may be saturated with about 1% WPI. After adding WPI, ST results for nectar were consistent across studies (Fang Z. [5]).

Amphiphilic components such as -lactoglobulin, -lactalbumin, blood serum albumin, etc immunoglobulins are prevalent in whey protein. To put it another way, the ST of a solution is decreased because of the presence of surface-active molecules in WPI, which migrate primarily to the atmosphere interface. However, overall ST of a feeding solution was unchanged by the introduction of MD at any concentration because sugars lack surface activity. When increasing the WPI ratio, there was little change in ST, suggesting that only approximately 1% of WPI is absorbed at the wind interface. This result suggested that the surface of the droplets had reached its maximum capacity for protein molecules, and that adding more protein to the core would not increase the number of protein molecules that could infiltrate the surface. It turns out is that we can get very close to 100% protein cover on the surface of the particles but with just 0.125% nominal protein in the feed.

Researchers into the action of solvent in water have discovered that a higher ST value is linked to a higher charge density in water. The ST number of solutions may be reduced through the action of hydrophobic protein molecules diffusing to and attaching to freshly formed water/air or liquid interfaces. As a result of adsorption, many cysteine residues in proteins partially unfold, exposing them to the non-aqueous solvent. It has been found that protein molecules, which generally partition here between aqueous and quasi stages, are able to stay adsorption at the interface and reduce the interfacial tension.

4.3 Recovering Powder

To get the powder recovery estimate, we only employed the item collection containers to gather powdered foam berry powder (Rp). Solutions of strawberries, Pm, and WPI were sprayed dried at the same load (11g/100g), and then solutions with varying ratios of S: MD: WPI were sprayed dried for analysis. However, when only berry puree was sprayed and dried, all the particles adhered to the drier wall and no powder were collected. Conclusion: When using just spray-dried samples as standards, Rp for WPI and Mda was 892.1 cent and 861.7 percent, respectively. To boost Rp, mix extra MD and WPI with the strawberry puree. Once MD was used to replace 30% and 50% of a strawberry's Ts (total solid content), respectively, the Rp climbed to 15% (1.1%) and 42% (1.8%). When more than half of the berries had MD in place of TSS, it was a challenge to collect the powder. When WPI was substituted with either 20% or 30% of a cherry Hs, the Rp increased to 38.25% and 48.23%, respectively. It appeared from our preliminary investigation that the Ri was below 50%. While using simply a carrier, our initial attempts to determine the optimal proportion of strawberry Ts to MD or WPI yielded a Rp of less than 50%. Bhandari and Howes argue that a Rp from the less that 50% is too poor effectiveness and increased energy cost, and so should be utilised as the spray drying success criterion.

4.4 Particle size distribution and bulk density (DB)

Distribution probability (DB) was positively correlated with particle diameter in the distribution and handling of these powders. The Pd of paint raspberry powder dropped (p 0.05) from –0.55 to 0.008 g mL1 as the WPI total soluble ratio in the feeder fluids increased from 0% to 10% and the MD high cement ratio fell from 40percent of total to 30%. Using soy protein extract and Dm as wall components, our results drying papaya pulp were comparable to those found by Muzaffar et al. The decreasing DB found with higher WPI ratios inside the feed solutions is then attributed to the decreasing surface of strawberry powder, as illustrated in micrograph micrographs (SEMs). All three of these factors – particle size, physical properties, and particle agglomeration – influence particle DB.

Foam berry powder volumetric median dscc was significantly related to feed solution content (p 0.05). From 8.87 0.01 down 7.12 mm m, particle size was lowered. When the Dm form four – fifths to 30 percent in the water and the total solids ratio is less than or equal to 0.15! When the higher solid percentage in the feed solution increased from 0% to 10% WPI and decreased from 40% to 30% MD, the number of powder particles was observed to decrease from 8.87 to 7.12 per milliliter (MD). The pore width of spray-dried powder was affected by the materials used, the feed rate, and the total soluble percentage of MD or Price indices in the feed fluids.

4.5 Temperature at which a glass can no longer be melted

The glass transition is the temperature-dependent phase transition from a hard or moderately fragile "glassy" state to a fluid or rubbery state that happens in polymorphs (or in amorphous portions within semi crystalline materials) [20]. Thinking of the Tg of sugary foods as a painting powder will help you estimate how sticky things will be. The Tg of low-molecular-weight carbohydrates and carbs is typically believed to be 10 °C to 20 °C higher than the temperature at which droplets or particles form. Compared to the values published by Shi et al., MD and WPI alone had Tg levels of 141.14 °C & 128.5 °C, respectively. The difference might be explained in part by seasonal changes in water content.

Interaction between the components affected the Tg of foamy berry powders significantly (p 0.05). As the loading rate of total soluble solids decreased form 40% to 30% for MD but from 0% through 10% for WPI, the powdered Tg rose between 32.60 1.16 °C through 38.39 1.83 °C. Powders made of S: MD: WPI with the accompanying compositions were statistically different: 60:40:0, 60:39.5:0.5, or 60:39:1. (p 0.05). In a study conducted over the previous decade, Fang and Bhandari found that Tg of Single – phase plus 2 juice powder did not vary considerably while the WPI concentration increased from 0.5 percent. The transition point (Tg) of foam honey is defined as the point at which the ratio of the amount of MD: WPI powders changes from 0% to 39.5%. Maybe the differences are just how the materials work. S: MD: WPI ratio of 60:39:1, 60:35:5, and 60:30:10 have been reported to yield more powder recovery than S: MD: WPI ratio of 60:40:0 or 60:39.5:0.5, which seems to be consistent with findings.

Surface morphology

The figure displays the scanning electron micrograph morphologies of strawberries powder foam made with various drying aid formulations.

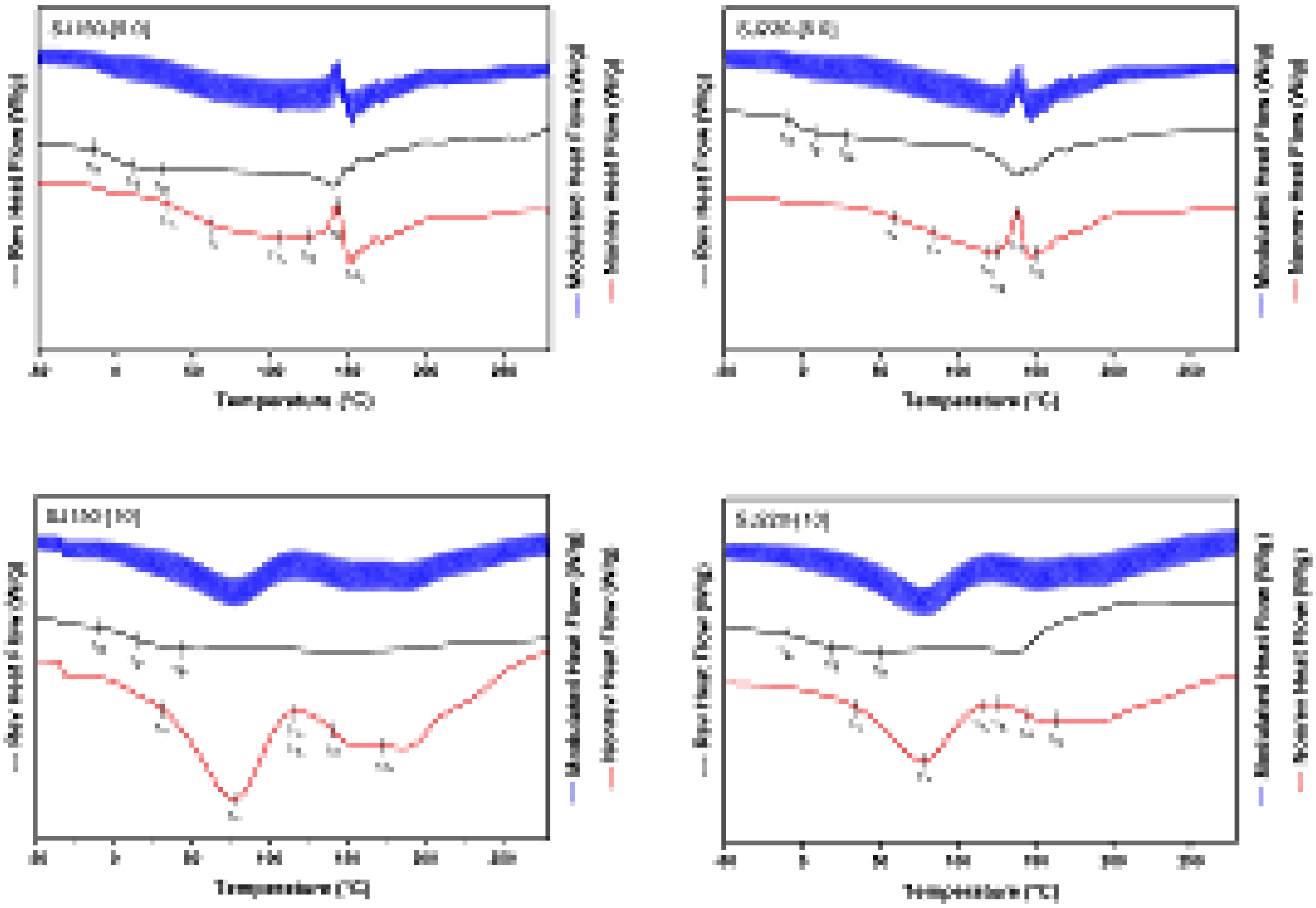

Figure 5. MDSC thermograms of SJ-MX powders prepared at the extreme drying conditions of MX concentration and inlet temperatures

The jet plum powder shown in Figure (a) had a Doctor proportion of 40:0 and had round, smooth particles. The accumulation of smaller particles on top of the larger ones is indicative of particle agglomeration. According to Figure 4, particle surface area was reduced after WPI was added (b-e). The nanoparticles' shape was not entirely spherical even after the introduction of 0.5% WPI. The particle size of strawberry powder was reduced while the moisture percentage (WPI) was increased from 5% to 10%.

5. Conclusions

Small levels of fructose (MX) and somewhat low drying temperatures were used to successfully sun dry cranberry juice (SJ). Researchers determined that an MX concentration = 5% and an input heat of 185 C result in the best drying conditions for preserving bioactive chemicals. Here, the settings were ideal for the development of nanotechnology for bioactive components with TPC and AA characteristics. The low – molecular – weight carbohydrates in SJ likely explain why the transition temperature of SJ-MX powders is lower than that of MX powders. Thermogravimetric examination disclosed the loss of water, a thermal degradation of sugar in Sx, as well as the thermal degradation of carbohydrates with a high molecular weight in MX. On the other hand, scanning electron microscopy revealed that moderate and high MX dosages produced powders with the most robust microstructure.

Businesses are able to 2021, 26, 5466, 13, or 14 were all found to be in an amorphous condition when their microstructure was analysed using X-ray diffraction on dried samples. Because the powder particles are protected from chemical and biological processes, the bioactive components can be retained through the process of microencapsulation. This study expands our understanding of spray dried apple juice, sweetener solutions, and heat-sensitive chemicals, all of which may find usage in the food and pharmaceutical industries.

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