# *Chapter-5*

## *Utilization of the papaya peel phytochemical extract for the enrichment of spray-dried watermelon juice powder*

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## 5.1 Introduction

Today's consumers take great care to maintain a healthy diet and way of life. The desire for natural and health-improving components has actually increased, according to various researches. However, some of the natural components deteriorate during processing. Natural substances derived from plant byproducts can be thought of as a good substitute for synthetic substances in this situation **[9,32]**. Additionally, the utilization of byproducts enables the manufacturer to avoid incurring additional costs for their disposal while also minimising the impact on the environment. The primary sources of natural phytochemicals are unquestionably fruits and vegetables.

Watermelon (*Citrulus lanatus*) has drawn special attention in the current study due to its well-known health benefits **[28]**. Tropical Africa is the home of the watermelon, which is a well-liked summertime thirst quencher. Lycopene, a carotenoid, is known to be present in watermelon juice in high concentrations. Watermelon has been shown to have a greater lycopene concentration than a lot of other fruits and vegetables **[10,18,27]**. Moreover, because of its β-carotene content, watermelon is a strong source of vitamin A and a great source of vitamin C. The body need the aforementioned vitamins as key antioxidants to combat free radicals.

Since watermelon is a fruit that is only available seasonally, it would be beneficial to have a watermelon product that is accessible throughout the year, given its considerable nutritional benefits.The watermelon juice can be transformed into a powder that is easily accessible and has a longer shelf life by using spray drying. The procedure of spray-drying is effective, easy to scale, and inexpensive. However, spray drying has the drawback of having the potential to swiftly damage active components at high processing temperatures. Similar findings by Oberoi & Sogi **[25]** and Saikia et al. **[30]** demonstrated that the total phenolic content and antioxidant activity of juice decrease following spray drying. Consequently, a phenol-rich component can be added to the spray-dried powder to increase its phenolic concentration.

In this work, the lost phenolic content is replenished by a phenolic-rich papaya peel extract produced by the freeze-drying method. Although freeze drying is very effective at drying heat-sensitive materials and freeze-dried foods retains their basic nutritional properties **[8]**. Even though, it was reported that freeze-drying of papaya peel contain greater amount of physicochemical properties compared to others fruits **[14,23]**. Moreover, Singla et al. **[32]** also reported that papaya peel contains a significant amount of phenolic chemicals.

This study was carried out because there isn't much scholarly material on the drying of watermelon juice. The practicality of spray drying watermelon juice was therefore studied in this work, along with the physicochemical characteristics of the powder obtained, including lycopene content, moisture content, water activity, dissolution, and color. Furthermore, no studies examining the effects of integrating the phytochemical extract from papaya peel with spray-dried watermelon juice powder have been found.

## 5.2 Materials and methods

### 5.2.1 Raw materials and chemicals

Fresh watermelons and papaya were procured from a local market in Tezpur, Assam, and brought to the Food Engineering and Technology Department of Tezpur University, Assam, India. Fruits with flawless skin and based on their ripened stage were selected for the studies. The selected fruits were washed in clean water. The skins were then manually peeled off, and the seeds were separated.

The maltodextrin was acquired from Merck, India. All other chemicals, including the Folin-Ciocalteu reagent 2 N, DPPH (2,2-diphenyl-1-picrylhydrazyl), gallic acid, sodium carbonate anhydrous, sodium bicarbonate, methanol, and ethanol, were procured from Zenith India, Assam.

### 5.2.2 Experiment design

The study employed a full factorial design to conduct the experiment. Three levels of inlet temperatures i.e., 130°C, 140°C and 150°C and two levels of maltodextrin i.e. 3% and 5% were used to obtain the SWP. The optimized condition was selected

based on moisture content, water activity, dissolution, color measurement, lycopene content and particle density parameter, respectively. The optimized powder was enriched by the FPP at different concentrations (0.5%, 1%, 1.5%, 2 and 2.5%). Further, total phenolic content, antioxidant activity and sensory analysis were carried out to confirm the enrichment. Moreover, the experimental procedure was illustrated in Figure 5.1.

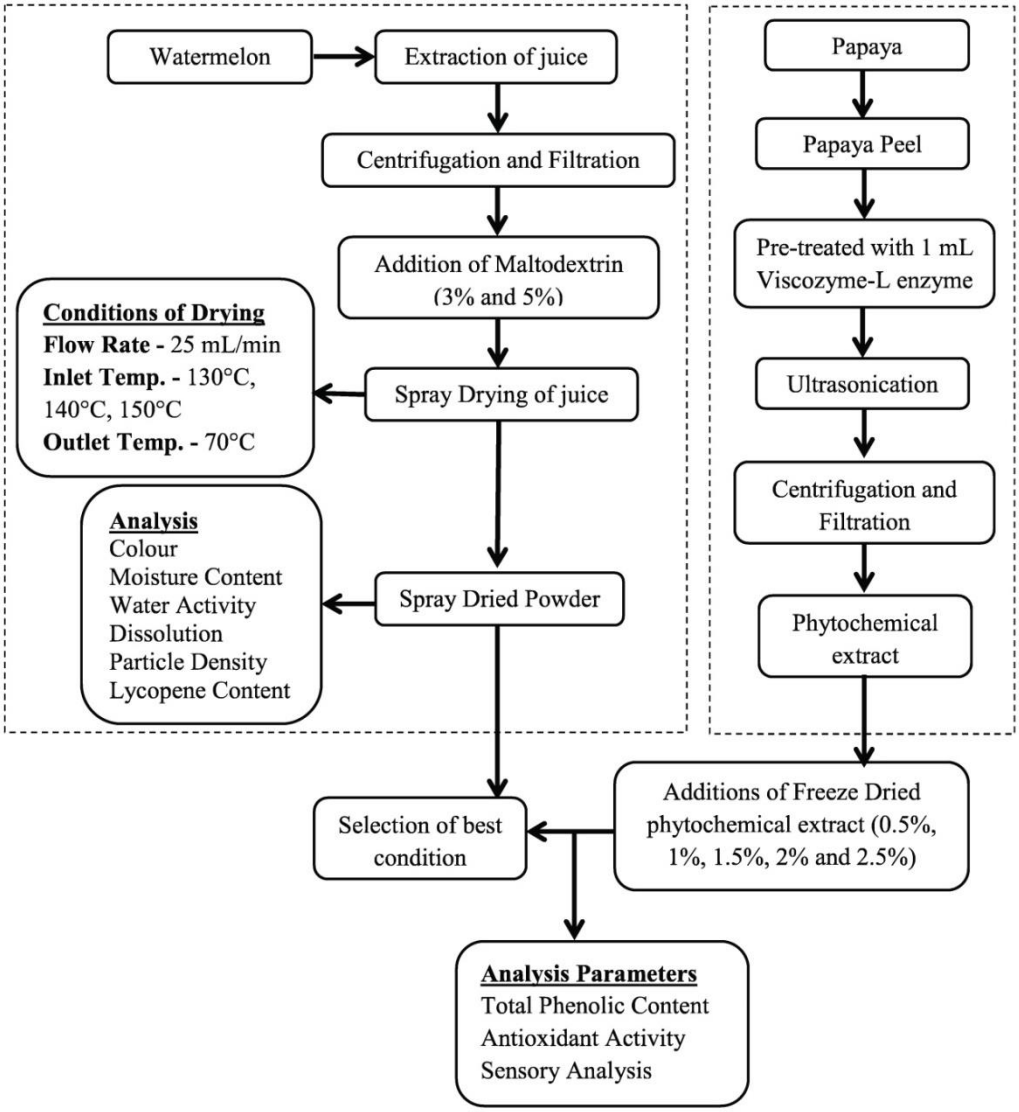


**Figure 5.1:** Overview methodology of the experiment work

### 5.2.3 Preparation of watermelon fruit juice and spray drying

Fresh watermelons weighed around 500 g and were sliced into approximately 3cm cubical pieces for each run. An electrical laboratory blender was used for the extraction of juice (Philips HL 1632, India). After this, the juice is vacuum-filtered

through an 11-m nylon mesh and the watermelon juice was kept in the refrigerator for one hour. The pH, color, total solid content, and lycopene content of the watermelon juice were all analysed.

For the spray drying procedure, a laboratory spray-dryer (Spray Mate 2011CC, JISL, India) was used. The process of spray drying was done at a flow rate of 25 mL/min and a 60% aspirator rate. These conditions were chosen after preliminary testing runs. Three different input air temperatures were employed in the study: 130°C, 140°C, and 150°C. To encapsulate the watermelon juice, maltodextrin was added at a concentration of 3% and 5% w/w. The dryer was washed with water for 15 minutes before and after the spray drying process, using the desired parameter setting. All of the powders that had been sprayed-dried were collected in compact containers of specified weight. The obtained powders were measured, placed in sealed containers, and preserved in the dark at 4°C.

### 5.2.4 Preparation of a phytochemical extract from papaya peel via freeze-drying

The phytochemical extract was produced using the approach described by Singla & Sit, 2022 under optimal conditions. Slices of papaya peel were blended with distilled water (1:2) and 1 mL of viscozyme L. Incubated the mixed paste for one hour at 37°C. In the case of ultrasonic assistance, extraction was carried out for 30 minutes at a constant temperature of 30°C with a continuous application of sonication using an ultrasonic bath (Genaxy Scientific - SK3300LHC) at a frequency of 53 kHz and a power of 100 W. After that, the sample was centrifuged, and the supernatant was freeze-dried.

### 5.2.5 Determination of pH and total soluble solids of watermelon juice

The pH level of the freshly extracted watermelon juice was determined by means of a pH meter(Eutech Instrumentrs, ECPH70042S, Singapore).

The total soluble solids (TSS) concentration was determine using a handheld refractometer (Erma Inc., RHB-32), and represented in degree Brix.

### 5.2.6 Analysis of the spray-dried powder

As described in Sections 2.6.1-2.6.6, the moisture content, water activity, dissolution, color, lycopene content, and particle density of the spray-dried powders were evaluated.

#### 5.2.6.1 Moisture content

The AOAC **[3]** technique was used to determine the moisture content. Weighed SWP samples in triplicate (20 mg each) were then dried for 24 hours at 70°C in a vacuum oven (Omega instruments, VO-64). After being taken out of the oven, the samples were cooled inside a desiccator, and subsequently weighed. Until a steady weight was achieved, the drying and weighing procedures were repeated.

#### 5.2.6.2 Water activity

A water activity metre was utilized to measure the water activity of the powder (Aqualab 4TE, USA). The mean was calculated after the analysis of three replicate samples.

#### 5.2.6.3 Dissolution test

A modified version of Fazilah et al. **[11]** dissolution test was used. A small test tube was filled with a sample that weighed around 100 mg. After that, distilled water was introduced, and the mixture was subjected to vortex mixing at half the maximum speed. Using an electronic timer, the amount of time needed to fully reconstitute the powders was recorded in seconds.

#### 5.2.6.4 Color measurement

The color analysis was conducted using a colorimeter (Ultrascan VIS, Hunterlab, USA) in accordance with the procedure given in Vivek et al. **[35]**. The CIE (Commission Internationale de L'Eclairage) Lab* color space was employed in the colorimeter analysis, which employs three parameters—L*, a*, and b*—to determine a color's precise position within a three-dimensional visible color space. Prior to the sample analysis, calibration was done on the white color tile (L* = 91.0, a* = +0.3165, b* = +0.3326). The lightness, or parameter L*, has a range of 0 for black to 100 for white. The a* parameter (which represents green to red dimension) and b* parameter are the two color coordinates, and they have a range between -120 and +120. (blue to yellow dimension).

#### 5.2.6.5 Lycopene content

The method of Kong & Ismali **[20]** was used to measure the lycopene content with some modification. 0.5g sample was mixed with the solution containing acetone-

ethanol-hexane (1:1:2 ratio) and it was vortexed for 20 minutes. After that, 3 mL of distilled water was added, and the vortexing process was repeated for 5 minutes. The mixture was then left to undergo phase separation in the separating funnel. UV-Vis spectrophotometer (Cary 60 UV Vis, Agilent Technologies) was used to measure the hexane extract at 503 nm. The blank was made of hexane. Lycopene was measured using a standard curve made of pure lycopene (mg/mL).

#### 5.2.6.6 Particle density

Particle density of SWP was determined by gas pycnometry (Porous materials, PYC-100A, USA) using helium gas. The apparent particle density were analyzed using a 10 $cm^3$ sample cell. Samples were weighed before analysis.

### 5.2.7 Analysis of incorporated powder

Different concentrations of the phytochemical extract (0.5%, 1%, 1.5%, 2%, and 2.5%) from freeze-dried papaya peel were added to the SWP. The parameters listed below were examined in accordance with sections 2.7.1-2.7.3.

#### 5.2.7.1 Total phenolic content

The standard Folin-Ciocalteu method, as described in Singla et al. **[32]**, was slightly modified to determine the total phenolic content (TPC) of the powder. In the test tube, a 0.5 mL sample aliquot was diluted in 2.5 mL of Folin-Ciocalteu reagent (diluted 1:10 with water). The test tube was filled with 2 mL of a 7.5% $Na_2CO_3$ solution after waiting for 5 minutes. After 2 hours of room temperature incubation, the samples were examined with a UV-Vis spectrophotometer to determine the absorbance at 765 nm in comparison to a blank reagent (Cary 60 UV Vis, Agilent Technologies). The Gallic acid equivalent (GAE) of the TPC was calculated as mg GAE/100 g of dry weight.

#### 5.2.7.2 Antioxidant activity (DPPH assay)

The method used by Kulkarni **[22]** was adopted to evaluate the antioxidant activity of enriched powder through the standard DPPH technique. Initially, 0.1 mL of sample was mixed with 3.9 mL of DPPH solution and vigorously shaken for 2-3 minutes. The mixture was then incubated in the dark at room temperature (23±2°C) for 1 hour. The absorbance was measured at 517 nm using a UV-Vis spectrophotometer

(Agilent Technologies, USA, Cary 60 UV Vis) and methanol was employed as a blank. By utilizing a formula, the scavenging capacity of the papaya peel extract was assessed.

$$Antioxidant\ Activity\ (\%) = \left(\frac{A_{Control} - A_{Sample}}{A_{Control}}\right) * 100$$

#### 5.2.7.3 Sensory evaluation Test (0–9 Scale)

The sensory evaluation was conducted using a structured hedonic scale with nine points, ranging from "strongly disliked (1)" to "strongly liked (9)." A panel of 10 members, comprising semi-trained assessors, participated in the evaluation. The panellists rated various sensory attributes, including appearance, aroma, taste, color, and texture (mouthfeel).

### 5.2.8 Statistical analysis

Data analysis was carried out using SPSS software (version 20.0, IBM Corporation, New York). One-way ANOVA (analysis of variance) was conducted on triplicate data values. Mean ± standard deviation of three independent readings were reported, and Duncan's multiple range test ($p \leq 0.05$) was used to distinguish between the means.

## 5.3 Result and Discussion

### 5.3.1 Physiochemical properties of watermelon juice

The physical and chemical characteristics of the fresh watermelon juice utilized for spray drying are displayed in Table 5.1. The high pH value of the watermelon juice (5.18), suggests that it is prone to microbial growth. Watermelon juice, like other fruit juices, included sugars (glucose, fructose, and sucrose) that would increase the stickiness of powder during spray drying **[2]**. The addition of maltodextrin raises the overall soluble content, as seen in table 5.1. Lycopene and β-carotene levels were used as markers for nutrient retention after spray drying. The high L* and +a* values show that watermelon juice is a brilliant red color. Color assessment is a crucial quality indicator, as it represents the sensory appeal and quality of the powders created during the spray drying process.

**Table 5.1: Physiochemical properties of watermelon juice**

| Parameters | MD (0%) | MD (3%) | MD (5%) |
|---|---|---|---|
| pH | $5.18 \pm 0.06^{b}$ | $5.24 \pm 0.05^{ab}$ | $5.28 \pm 0.02^{a}$ |
| TSS (%) | $5.56 \pm 0.50^{c}$ | $9.26 \pm 0.62^{b}$ | $12.36 \pm 1.09^{a}$ |
| Color | | | |
| L* | $80.49 \pm 0.56^{b}$ | $81.94 \pm 0.59^{a}$ | $82.29 \pm 0.39^{a}$ |
| a* | $36.02 \pm 0.40^{a}$ | $35.10 \pm 0.54^{b}$ | $34.25 \pm 0.34^{b}$ |
| b* | $12.69 \pm 0.27^{a}$ | $13.18 \pm 0.23^{b}$ | $13.77 \pm 0.38^{b}$ |
| Lycopene Content | $51.93 \pm 0.56^{b}$ | $51.11 \pm 0.19^{b}$ | $51.03 \pm 0.28^{a}$ |

values are expressed as mean ± standard deviations. Means in a same row with different superscripts indicate significant difference ($p < 0.05$).

### 5.3.2 Physiochemical properties of spray dried watermelon juice powder

#### 5.3.2.1 Moisture content

The results indicated that with a constant feed flow rate, an rise in the inlet temperature resulted in a decrease in the moisture content of the SWP, as shown in Table 5.2.This is because moisture evaporation is more accelerated at higher inlet temperatures due to a faster rate of heat transfer to the particle. As a result, powders with lower moisture contents are produced. The outcomes matched those of earlier studies **[17,28]**.

The findings also indicated that adding more maltodextrin reduced the moisture content of the SWP. The final moisture content of the powder generated in a spray drying procedure is influenced by the water content of the feed **[1]**. Prior to spray drying, maltodextrin was added to the feed, increasing the overall solid content while lowering the water required for evaporation. Consequently, the moisture content of the powder generated was reduced. This meant that by increasing the percentages of maltodextrin added, powders with reduced moisture content may be produced. However, if the maltodextrin percentages were too high, the vital nutrient's from the watermelon juice would be decreased, resulting in a lower-quality powder being obtained.

#### 5.3.2.2 Water activity

Water activity is a crucial indicator for SWP since it has a significant impact on the shelf-life of the final product. It is described as the difference between the vapour pressure of pure water at the same temperature and the vapour pressure of water in a

food system **[12]**. Any biochemical or microbiological responses in a food system are caused by the presence of free water, which is referred to as water activity. A shorter shelf life is caused by high water activity because it makes more free water available for metabolic processes **[13]**. Food that has a water activity of less than 0.6 is typically thought to be microbiologically stable, and any deterioration that does occur is typically caused by chemical reactions rather than microorganisms. According to the outcomes (Table 5.2), the obtained powders water activities ranged from 0.2-0.28. This indicated that the SWP obtained were generally microbiologically stable. The storage conditions, however, were also crucial in this situation. The research also demonstrated that as maltodextrin content increased, water activity reduced. These findings agreed with those of previous researchers **[16,25]**. Researchers Tonon et al. **[34]** and Quek et al. **[28]** who studied acai powders and watermelon, respectively, came up with similar water activity values.

#### 5.3.2.3 Color

As it represents the sensory appeal and superiority of the powders, color is a crucial quality component **[5]**. Even while a functional food can offer consumers a number of health benefits, it cannot be commercially successful without appealing to consumers visually. In order to remind customer of the original product, the color of commodities should preferably not alter after manufacture. Table 5.3 displays the outcomes of the color assessments for SWP. The maltodextrin concentration and inlet temperatures had a significant impact on the color values in L*, a*, and b* of the SWP ($p \leq 0.05$). It was discovered that the L* and b* values increased while the a* values decreased when the maltodextrin concentration increased. Similar findings were made for the drying of mountain tea's water extract **[24]**. It was claimed that the SWP lost their red-pink color with the addition of 5% maltodextrin. Watermelon juice concentrate is dark pink, whereas maltodextrin granules are white. As a result, each powder produced was light pink in color. The proportion of watermelon juice solids to maltodextrin solids, the level of caramelization inside the dryer, and the moisture content all had an impact on the precise color of each powder. The lowest values for a* are seen in powder containing 5% maltodextrin and dried at 150°C temperature, which is the lightest in color of all powders due to the highest inlet temperature and largest ratio of maltodextrin solids.

**Table 5.2: Physiochemical properties of spray dried powder**

| Temp. (°C) | Maltodextrin (%) | Moisture Content (%) | Water Activity (%) | Dissolution (Time)(s) | Lycopene Content (µg/g) | Particle Density ($g/cm^3$) |
|---|---|---|---|---|---|---|
| 130 | 3 | $6.883 \pm 0.011^{a}$ | $0.281 \pm 0.002^{a}$ | $24.63 \pm 0.43^{e}$ | $956.02 \pm 3.01^{a}$ | $1.224 \pm 0.02^{a}$ |
| 130 | 5 | $6.783 \pm 0.025^{b}$ | $0.259 \pm 0.007^{b}$ | $29.23 \pm 0.83^{c}$ | $898.34 \pm 0.93c$ | $1.12 \pm 0.017^{c}$ |
| 140 | 3 | $6.386 \pm 0.035^{c}$ | $0.260 \pm 0.001^{b}$ | $27.64 \pm 0.56^{d}$ | $909.66 \pm 2.05^{b}$ | $1.192 \pm 0.02^{b}$ |
| 140 | 5 | $5.943 \pm 0.020^{d}$ | $0.217 \pm 0.001^{d}$ | $32.63 \pm 0.56^{b}$ | $834.16 \pm 3.11^{de}$ | $1.08 \pm 0.019^{d}$ |
| 150 | 3 | $6.300 \pm 0.010^{c}$ | $0.250 \pm 0.001^{c}$ | $30.10 \pm 0.65^{c}$ | $823.36 \pm 1.93^{e}$ | $1.14 \pm 0.019^{c}$ |
| 150 | 5 | $5.726 \pm 0.035^{e}$ | $0.202 \pm 0.003^{e}$ | $35.00 \pm 0.47^{a}$ | $726.44 \pm 1.15^{f}$ | $0.98 \pm 0.01^{e}$ |

values are presented as mean ± standard deviations. Means in a same column with different superscripts indicate significant difference ($p < 0.05$).

**Table 5.3: Color measurement of spray dried powder**

| Temp. (°C) | MD (%) | L* | a* | b* |
|---|---|---|---|---|
| 130 | 3 | $78.66 \pm 0.26^{e}$ | $14.45 \pm 0.11^{a}$ | $4.90 \pm 0.08^{b}$ |
| 30 | 5 | $79.48 \pm 0.44^{cd}$ | $13.72 \pm 0.53^{c}$ | $5.22 \pm 0.41^{b}$ |
| 140 | 3 | $79.14 \pm 0.32^{de}$ | $14.25 \pm 0.23^{b}$ | $4.89 \pm 0.15^{b}$ |
| 140 | 5 | $79.87 \pm 0.04^{bc}$ | $13.92 \pm 0.15^{bc}$ | $5.00 \pm 0.06^{b}$ |
| 150 | 3 | $80.10 \pm 0.20^{b}$ | $13.66 \pm 0.14^{c}$ | $5.08 \pm 0.11^{b}$ |
| 150 | 5 | $82.03 \pm 1.13^{a}$ | $12.95 \pm 0.06^{d}$ | $5.74 \pm 0.11^{a}$ |

values are presented as mean ± standard deviations. Means in a same column with different superscripts indicate significant difference ($p < 0.05$).

### 5.3.2.4 Dissolution test

The dissolution test was measured in terms of how long it takes for the powder to completely rehydrate after vortexing in water. The results (Table 5.2) demonstrated that the timeframes required for the powders to fully reconstitute in water were substantially shorter at lower inlet temperatures. This phenomenon was most likely connected to the amount of moisture in the powder that was developed. The evaporation rate was slower at lower inlet temperatures, resulting in powders with larger moisture contents. The higher tendency of agglomeration in this form of powder increased the powders ability to reconstitute **[25]**. The findings demonstrated that there was a favourable correlation between powder moisture content and dissolution (Table 5.2). This is consistent with the conclusion reached by Goula et al. **[17]**. Conversely, a hard surface layer may form throughout the powder particle at higher inlet temperatures. As a result, water molecules might not be able to diffuse through the particle. Reduced wetting ability of the particle and decreased powder dissolution as a result **[6]**.

### 5.3.2.5 Lycopene content

When watermelon juice was processed by spray drying, it was discovered that lycopene content reduced significantly ($p \leq 0.05$) while maltodextrin level and inlet temperature increased (Table 5.2). The high temperature and oxygen exposure during the spray drying process caused a notable reduction in lycopene content (from 956.02 to 726.44 μg/g). As per the result, the highest lycopene content was noticed in the powder

dreid at 130°C with 3% maltodextrin (956.02 µg/g) followed by 140°C with 3% maltodextrin (909.66 µg/g) and lowest value was observed at 150°C with 5% maltodextrin due to high temperature and more amount of maltodextrin. Instead of gradual alteration from the all-trans to cis form, the drop in lycopene after spray drying was caused by real lycopene breakdown **[16]**. Goula et al. **[17]** came to the conclusion that because the product was transformed into droplets during the spray drying process, a greater surface area accessible to air facilitates lycopene oxidation. Since, lycopene gets oxidised, its health-related characteristics are lost along with it, which is why oxidation is undesirable **[29]**. According to Quek et al. **[28]**, the amount of lycopene in SWP reduced from 95.4 to 72.5 mg/100g as the temperature raise from 145 to 175°C. When boiling tomato pulp at 100 °C for two hours, Cole & Kapur **[7]** noted a 25% apparent lycopene reduction in the presence of oxygen. The pigment content is also impacted by an increase in maltodextrin because the pigment is diluted **[25]**.

#### 5.3.2.6 Particle density

Pycnometry revealed that the maltodextrin concentration and input temperature had an impact on the particle density of the SWP, i.e., larger solid contents led to particles with lower particle densities (Table 5.2). The SWP output varies from 0.98 to 1.22 g/cm$^3$. With rising maltodextrin content, it was seen that particle density significantly decreased ($p \leq 0.05$). This outcome might be described by the fact that the inclusion of maltodextrin reduces thermoplastic particles' tendency to stick together as well as the powder's tendency to attach to surfaces or be less freely flowing **[15]**. The fraction of insoluble solids increases as temperature rises because a hard surface layer forms throughout the powder particles, preventing water from penetrating them. As per the findings of Walton **[36]**, elevating the temperature of the drying air generally leads to a decrease in both bulk and particle density, as well as a greater tendency for the formation of empty particles. The results of Chegini & Ghobadian **[6]**, research support this conclusion. Raising the input air temperature causes a rise in the average time of wettability (i.e., a fall in wettability). Large particles occupy more space, making it easier for water to penetrate them, but smaller particles are less porous, making it harder for water to penetrate them and reducing their ability to reconstitute. Additionally, the particle size distribution may have an impact on ingredients mix, blend properties **[33]**.

### 5.3.3 Properties of enriched spray dried powder

When maltodextrin concentration and inlet/outlet temperature were rise, the lycopene content of powders reduced significantly ($P \leq 0.05$). Nadeem et al. **[24]** also observed the same influence of the carrier agent on the TPC of mountain tea powder. However, this reduction was only a result of the dilution effect, as increased carrier concentrations resulted in a marginal reduction in the percentage of phenolic component oxidation. This study findings agreed with those of the researchers **[26]**. Although the phenolic content of watermelon juice and their antioxidant activities are related, the total phenolics content does not include all of the antioxidants found in the watermelon. In this study for spray drying of watermelon juice were enriched with FPP. Fruit by-products, such peel and seed fractions, can include a variety of beneficial compounds, like phenolics, carotenoids, and flavonoids, and, like the fruit pulp itself, they might have a high antioxidant potential **[19]**. The peel of the papaya fruit is rich in anti-inflammatory and antibacterial substances such phenolic acids, organic acids, hydrolysable tannins, and flavonoids and were utilized to boost the phenolic content of SWP.

To assure the development of high quality SWP, the physicochemical characteristics of the powders are crucial. As per Arya et al. **[4]**, watermelon powder that has been dried is stable within the range of 0.22-0.25 for water activity. However, when the water activity value increases due to high moisture content, caking begins to occur. According to section 3.2, when compared the entire dried samples, watermelon juice dried at 140°C and 150°C produced the optimal moisture content and water activity. Also, color and lycopene content are the important parameter of dried powder. In accordance to Quek et al, **[28]**, the lycopene content of the optimized spray dried power was 907 µg/g which was almost similar to lycopene content obtained by SWP at 140°C. According to the findings, drying watermelon juice at temperatures above 140°C resulted in inferior products due to a decrease in lycopene content and color. The color of the spray-dried watermelon powder was predominantly affected by the inlet temperature and the amount of maltodextrin used. As the inlet temperature and maltodextrin concentration increased, the powders produced were light red. The results of the study indicate that the best quality powders with optimal moisture content, water activity, and lycopene content were obtained at 140°C with 3% maltodextrin,

demonstrating the potential for such powders to be used in the food industry. The nutritional content of optimized powder was then increased by adding FPP in various amounts (0.5%, 1%, 1.5%, 2%, and 2.5%).

**Table 5.4: Phytochemical properties of enriched powder**

| Batch | Concentration (%) | TPC (mg GAE/100g) | Antioxidant Activity (%) |
|---|---|---|---|
| C | 0 | $53.71 \pm 0.43^{f}$ | $5.82 \pm 0.64^{f}$ |
| E1 | 0.5 | $72.14 \pm 0.79^{e}$ | $9.19 \pm 0.11^{e}$ |
| E2 | 1 | $87.92 \pm 0.98^{d}$ | $11.76 \pm 0.76^{d}$ |
| E3 | 1.5 | $101.23 \pm 1.13^{c}$ | $14.36 \pm 1.26^{c}$ |
| E4 | 2 | $119.40 \pm 1.02^{b}$ | $18.83 \pm 0.38^{b}$ |
| E5 | 2.5 | $130.34 \pm 1.24^{a}$ | $23.53 \pm 1.32^{a}$ |

values are presented as mean ± standard deviations. Means in a same column with different superscripts indicate significant difference ($p < 0.05$).

### 5.3.3.1 Phytochemical properties

The SWP had a total phenolic content that ranged from 53.71 mg GAE/100g to 130.34 mg GAE/100g. The amount of FPP added determines the total phenolic content of the SWP (Figure 5.2). For the extracts containing 0.5%, 1%, 1.5%, 2%, and 2.5%, respectively, the TPC of enriched watermelon juice powder was determined to be 72.14, 87.92, 101.23, 119.40, and 130.34 mg GAE/100g. The results indicate a significant variation ($p \leq 0.05$) across all the samples. The results for the total phenolic content of SWP were less than those from enriched powder in terms of TPC. Therefore, it's crucial to ascertain how the spray drying process affects the phenol level of the watermelon juice.

Due to the inhibition effect of free radicals in dietary and biological systems, radical scavenging activity is a crucial characteristic and a sign of antioxidant capability. Lycopene and beta-carotene, two prominent antioxidants that can be found in watermelon, contribute to the fruit's increased commercial appeal **[21]**. Georgetti et al. **[13]** stated that, apart from the concentration of the antioxidant ingredient, its chemical structure, as well as the interactions between different antioxidants, also plays a significant role in determining the antioxidant activity of a sample. Watermelon's

constituent components are quickly oxidised during the high-temperature spray drying process. Therefore, additional phytochemical extract was added to the SWP, greatly increasing its market appeal. The antioxidant activity of the dried powder without any enrichment was found to be 5.8%, while the antioxidant activity (%) of the enriched powder was found to be 9.19%, 11.76%, 14.36%, 18.83% and 23.53%, respectively (Table 5.4). It was noticed that antioxidant activity increasing significantly with increasing the concentration of FPP (Figure 5.3).

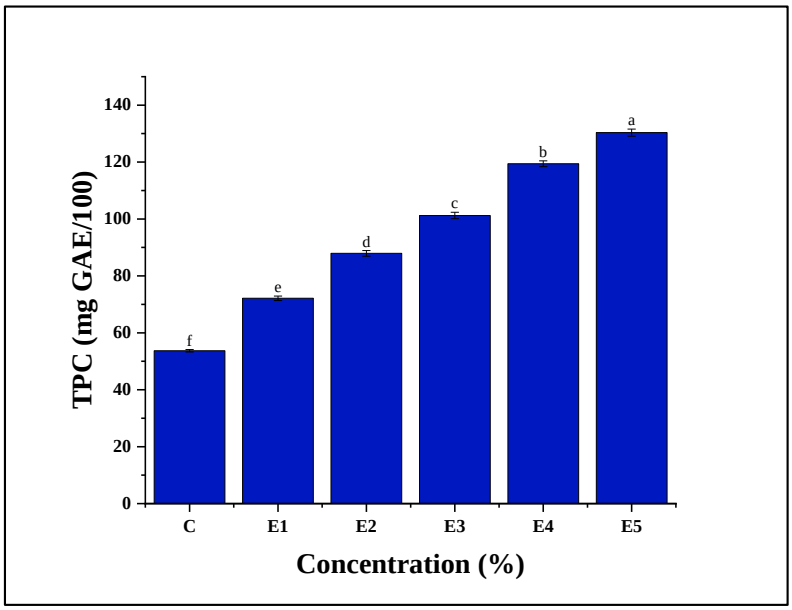


**Figure 5.2:** Total phenolic content of enriched spray dried powder

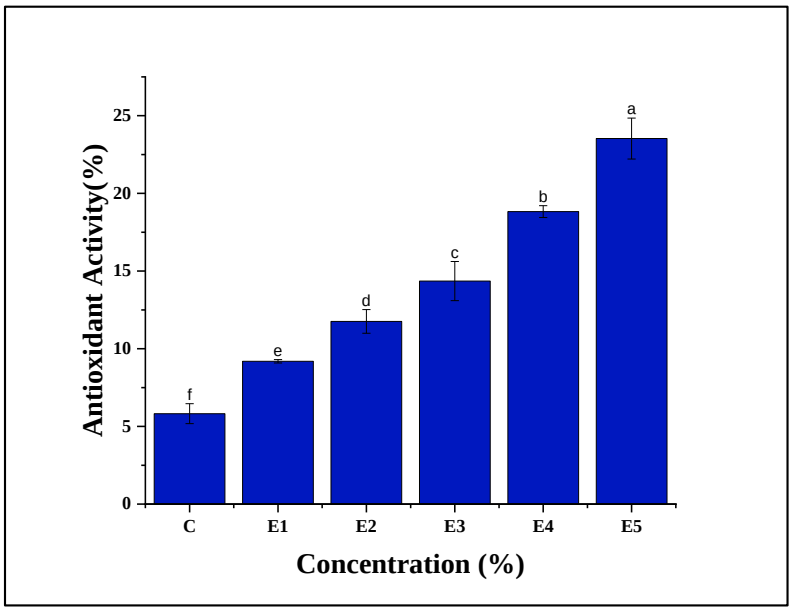


**Figure 5.3:** Antioxidant activity of enriched spray dried powder

### 5.3.3.2 Sensory evaluation

The aim of the sensory assessment process was to compare the reconstituted powder's color, aroma, taste, mouthfeel, and appearance. Figure 5.5 displays the average score of each characteristic received from the panelists. Figure 5.5 indicates that while there was no statistically difference ($p > 0.05$) seen in the color (Figure 5.4), aroma, and appearance of the enriched juice, but there was a significant variation ($p \leq 0.05$) in the taste and mouthfeel across the various formulations. Considering that up to E3 (1.5%) incorporation was deemed acceptable for phenolic compound enrichment,and the phenolic content in watermelon juice increased by approximately 88.56%, reaching 101.23 mg GAE/100g from the initial 53.71 mg GAE/100g.

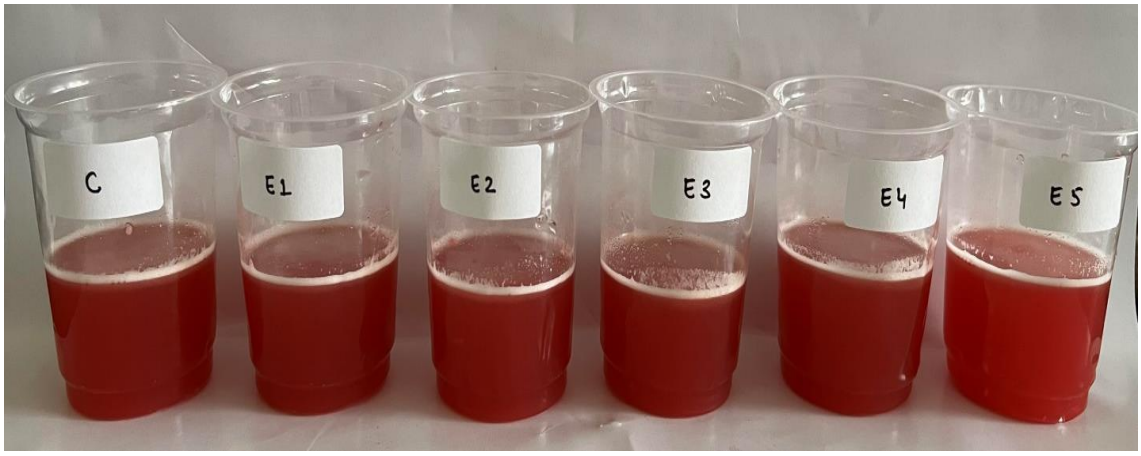


**Figure 5.4:** Reconstituted enriched spray dried powder

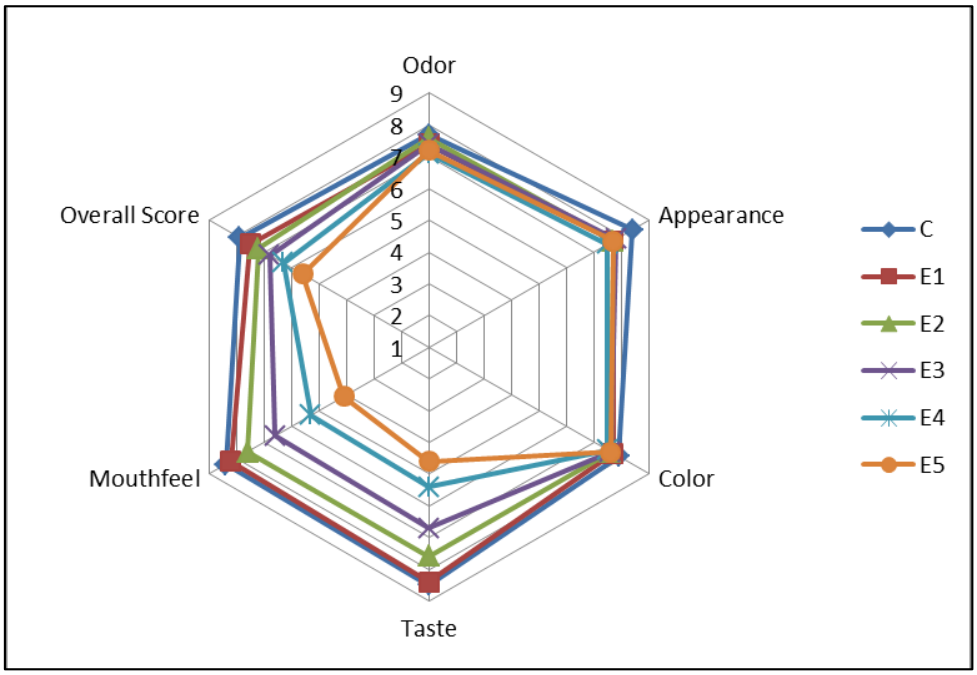


**Figure 5.5:** Sensory analysis of enriched spray dried powder

## 5.4 References


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