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Research Journal of Agricultural Sciences

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

International Conference on "Millets- Ensuring Food Security and Sustainable Farming"
Volume 14; Issue 04 (July-Aug 2023); pp 869–876

Full Length Research Article

Physiochemical and Functional Characteristic Assessment of Encapsulated Juice Powder

Subasshini V[1], Nazreen Bagum A[2] and Afroze Shameema Shareen M*[3]

[1-3] P. G. Department of Home Science, Food Science Nutrition and Dietetics, Shrimathi Devkunvar Nanalal Bhatt Vaishnav College for Women, Affiliated to University of Madras, Chrompet, India

Correspondence to: Afroze Shameema Shareen M, P. G. Department of Home Science, Food Science Nutrition and Dietetics, Shrimathi Devkunvar Nanalal Bhatt Vaishnav College for Women, Affiliated to University of Madras, Chrompet, India, Tel: +91 7871506202; E-mail: afrozeshasha@gmail.com

Abstract

Citrus juices and fruits are abundant in bioactive compounds. The main factors that contribute to vitamin C loss during juice preparation are temperature and oxygen. Fresh fruits and juices lose a lot of their nutritional value because they are perishable and sensitive to mechanical damage during handling, storage, and transportation. Encapsulation helps in preserving the nutritional value of juices, particularly the vitamin content. Spray drying is the most frequent and cost-effective way of encapsulating food ingredients. The effect of spray drying with inlet temperature of 150° C and maltodextrin levels of 10,15 and 20% on the physiochemical and functional characteristics of encapsulated guava and gooseberry juice powder were studied. Physiochemical properties such as powder yield, moisture content, colour analysis, hygroscopicity, bulk density, tapped density, dissolution test and functional qualities such as total phenol content, DPPH radical-scavenging activity, Vitamin C content and Encapsulation efficiency were analyzed. Physiochemical and functional properties were significantly affected by both maltodextrin and inlet temperature. Encapsulation efficiency was also significantly affected by the inlet temperature and maltodextrin levels. Spray dried guava and gooseberry juice powder with 20% maltodextrin and processed at 150° C inlet temperature had good physiochemical, functional properties and increased encapsulation efficiency ratio.

Key words: Encapsulation, Maltodextrin, Spray drying, Physiochemical, Vitamin C

Vitamin C is an essential water-soluble vitamin but cannot be synthesized by the human body. It helps in the prevention of scurvy, cancer, cardiovascular diseases etc. It also helps in biosynthesis of collagen which is important for wound healing and increases resistance to infection. (Jacob *et al.* 2002). Guava *(Psidium guajava Linn.)* a plant is widely distributed in subtropical and tropical areas of China, India, Indonesia (Sathe *et al.* 2015). It is well established that Guava is a good source of essential oils, phenols, flavonoids and contains minerals like calcium, phosphorous, iron and have lot of vitamins in it (Omayio *et al.* 2019). Gooseberry (*Emblica officinalis Gaertn*.), a plant of Euphorbiaceous is widely distributed in subtropical and tropical areas of China, India, Indonesia and Malaysia (Liu *et al.* 2008). It is well established that gooseberry is a good source of total phenolic content, antioxidants, flavones, tannins and other bioactive compounds (Zhang *et al.* 2003). However, being a seasonal fruit its availability as a fresh fruit is for a limited period. Hence encapsulation of the fruit juice using guava and gooseberry powders may be a good alternative to make its health promoting components available throughout the season.

Fruit juice powders have number of benefits over the liquid counterparts such as reduced volume or weight, reduced packaging, easier handling, transportation and longer shelf life (Goula *et al.* 2004). Spray dried powders have good reconstitutional characteristics, have low water activity and are suitable for storage. Spray drying technique is also appropriate for heat sensitive components (Khalid Muzaffar *et al.* 2018). Maltodextrin, gum Arabic and gelatin are successfully used as drying aids to facilitate drying (Sahin-Nadeem *et al.* 2013). Maltodextrin is one of the common drying aids for spray drying owing to its beneficial role as a carrier or an encapsulating agent. However, there are no reported studies on spray drying of Guava and Gooseberry juice powder to retain physicochemical, functional properties, encapsulation efficiency and health promoting factors (Chopda and Barrett *et al.* 2001). In the present study, Guava and Gooseberry juice was spray dried with different maltodextrin concentrations at 150 °C inlet temperature. The effect of spray drying on the physicochemical, functional properties and encapsulation efficiency of encapsulated guava and gooseberry juice powder are reported.

MATERIALS AND METHODS

Acquirement of raw materials

Guava of pink variety and Gooseberry were procured from local market in Chennai, India. The fruits were cleaned thoroughly under the tap water to remove adhering dust and wiped with muslin cloth. The washed fruits were used for development of Spray dried guava and gooseberry juice powder.

Standardization process for development of spray dried guava and gooseberry powder

Guava and Gooseberry were cut into small pieces and pulped in a domestic grinder. Juice was extracted by straining through double fold muslin cloth. Maltodextrin of varying concentration (10-20%) was added and homogenized for 15 mins at 5000 *rpm* (Carrillo-Navas *et al.* 2011). The juice was fed into spray dryer and spray dried at inlet temperatures of 150 °C (Shishir *et al.* 2014). Preliminary spray drying trials showed that at maltodextrin level of 10% most of the material stuck on chamber wall. Hence, levels of maltodextrin used in the study varied between 10% and 20% (Largo *et al.* 2015). Feed material for all the formulations came from a single batch of guava and gooseberry juice.

Spray drying conditions of fresh guava and gooseberry juice powder

The feed comprising of maltodextrin and juice was spray dried in tall type spray dryer (Chennai). The inlet temperature and outlet temperature were 150° C and 65° C. The Compressor pressure and feed rate were 2.0 bars and 350ml/h, respectively (Shishir *et al.* 2014).

Fig 1 Encapsulated guava and gooseberry juice powder

Analytical methods

Powder yield

The spray drying was estimated at the relationship between the mass of the final product and the mass of the feed mixture and calculated as (Leon-Martinez *et al.* 2010):

$$Y = \frac{(W2-W1)-Xwb(W2-W1)}{FvTs} * 100 \ldots\ldots(1)$$

Where Y is the powder yield (%), $X_{wb}$is the moisture content (wb), $F_v$is the feed volume, $T_s$is the total solid content, W_1 and W_2 are the weight of the powder bottle before and after spraying drying, accordingly.

Moisture content

The moisture content was determined according to the method of AOAC,927.05. One gram of sample was taken and dried in an oven at 70°C for 24 h, the samples are removed from the oven, cooled in a desiccator and weighed. The moisture content of the powder was expressed in dry weight basis (Aziz *et al.* 2014).

$$Moisture\ content = \frac{Weight\ of\ Water\ loss}{Weight\ of\ powder\ sample} * 100 \ldots\ldots(2)$$

Hygroscopicity

According to Schieber *et al.* (2020), Hygroscopicity was calculated as the moisture absorption observed after exposing the powders to humid air with 81% relative humidity. For the determination of the hygroscopicity, 1 g of powder was weighed in an aluminium dish and placed in a desiccator containing 200 mL of a saturated solution of Na_2SO4 at 25 °C. The weight gain was determined in triplicate after 1, 3, 7, and 24 hours and the moisture absorption was calculated with the following equation.

$$Moisture\ Absorption(\%)\ after\ 1{,}3{,}7{,}24\ hr = \frac{Weight\ gain\ after\ 1{,}3{,}7{,}24}{Weight\ of\ sample} * 100 \ldots\ldots(3)$$

Dissolution test

According to Srzednicki *et al.* (2021) A sample of 50 mg of dried powder was mixed with 1 ml of distilled water in a test tube. The solution was mixed in a vortex at a moderate speed. The time for the powders to dissolve in water was recorded. The test was carried out in triplicate.

Bulk density and tapped density

Bulk density was determined according to Sahin – Nadeem *et al.* (2013) method. The two-gram powder was taken into a 10 ml graduated cylinder (keep on plane level) and recorded the volume changes. The bulk density of the powder was estimated as the ratio of the mass of the sample to its volume.

Tapped density of the samples was determined according to the method suggested by Ozdikicierler *et al.* (2014).

$$Tapped\ density = \frac{Mass\ of\ the\ powder}{Volume\ after\ tapping} \quad (4)$$

The flowability of the powders was evaluated in terms of the Carr Index (CI) and Hausner ratio (HR), (Jinapong *et al.* 2008). Both CI and HR were calculated from the bulk and tapped densities of the powders as follows:

$$CI = \frac{Tapped\ density - Bulk\ density}{Tapped\ density} * 100 \ldots\ldots (5)$$

$$HR = \frac{Tapped\ density}{Bulk\ density} \ldots\ldots (6)$$

Table 1 Specification for Carr Index and Hausner Ratio

Flowability	Carr Index (CI)%	Hausner Ratio (HR)
Excellent	0-10	1.00-1.11
Good	11-15	1.12-1.1
Fair	16-20	1.19-1.25
Passable	21-25	1.26-1.34
Poor	26-31	1.35-1.45
Very poor	32-37	1.46-1.59
Very, very poor	>38	>1.60

Source: (Lebrun *et al.* 2012)

Colour analysis

According to Aishah *et al*. (2018), the color indices were measured using Hunter colorlab. (L* is a measure of lightness ranging from 0 (black) to 100 (white) and colour coordinates, *a** which takes positive values for redness colour and negative values for greenness and *b** positive for yellowness colour and negative for blueness.

Total phenol content

According to Eghdami and Sadeghi (2010), the first step was to combine 9 ml of an 80% methanol solution with 1 g of juice powder at 40 C for 24 hours before cooling at room temperature. 200 mL of the sample extract, 800 mL of the Folin-Ciocalteu reagent, 2 mL of the 7.5% sodium carbonate, and 7 mL of distilled water were combined. For one hour, the solution was left in the dark. A UV spectrophotometer was used to evaluate the sample mixture's absorbance at 765 nm. Gallic acid was used as a reference and its equivalents were measured in mg/100 g.

DPPH radical – scavenging activity

DPPH scavenging activity was determined according to the method suggested by Blois, 1958. The following formula was used to calculate the DPPH radical scavenging activity:

$$\text{Scavenging activity (\%)} = 1 - \frac{A1}{A0} * 100 \text{ ………….. (7)}$$

A_0 = the absorbance of the control solution (20 μL ethanol in 80 μL of DPPH solution)
A_1 = the absorbance of the 0.1% juice powder solution in DPPH solution after 30 min incubation (Blois 1958).

Vitamin C content

Ascorbic acid was estimated by using dye (2,6-dichlorophenol indophenol) following the procedure of Ranganna (1999). For this, 2ml both of Guava and Gooseberry juice was titrated using 0.1% of 2,6 dichlorophenolindophenol solution dissolved in 3% metaphosphoric acid to an appearance pink color. The ascorbic acid concentration was calculated according to the titration volume of 2,6-dichloroindophenol and expressed as mg /100 ml.

Encapsulation efficiency

Encapsulation efficiency was calculated based on total anthocyanin content in the juice before and after encapsulation by using the method suggested by Risch and Reineccius (1988).

$$EE = \frac{A}{B} * 100 \text{ ………….. (8)}$$

Where;
EE = Encapsulation Efficiency (%)
A = Total anthocyanin content in the feed emulsion (mg/100 g dry matter)
B = Total anthocyanin content in the encapsulated powder (mg/100 g dry matter)

Statistical analysis

To compute the mean and standard deviation, all experiments were repeated twice and all measurements were made in triplicate. The significance of the data was determined using one-way analysis of variance (ANOVA) and independent t-test were performed for the physical and antioxidant properties and T-test were performed for Vitamin C in the statistical analysis system SPSS version 14.

RESULTS AND DISCUSSION

Effect of spray drying conditions on physical properties of encapsulated guava and gooseberry juice powder

Powder yield

The effects of maltodextrin concentration on the physical properties of Guava and gooseberry juice powder are shown in (Table 2). The levels of maltodextrin used for development of guava and gooseberry powder varied between 10-20%. Increase in the maltodextrin concentration and inlet air temperature resulted in a significant (5% probability level) decrease in powder yield in the finished powder. It was found that both MD concentration and inlet temperatures have a significant impact on product yield, with higher MD concentrations resulting in higher production, and that increasing inlet air temperature had a random effect maximum yield of 37.5% for 10 % and 49.50% for 15% and 58.62% for 20% MD at 150 °C (Table 2). However, increasing the MD content in guava and gooseberry juice enhanced the process yield significantly.

Table 2 Physicochemical properties of encapsulated guava and gooseberry powder

Physical properties	10%MD	15%MD	20%MD	P-Value
Powder yield	37.5 ± 0.22^{c}	46.5 ± 0.321^{b}	53.06 ± 0.41^{a}	0.00
Moisture content	0.09 ± 0.008^{c}	0.1 ± 0.09^{b}	0.33 ± 0.02^{a}	0.00
Hygroscopicity	12^{c}	17.79^{b}	42^{a}	0.01*
Dissolution test	30 min	40 min	40 min	0.00
Bulk density	0.400 ±1.6	0.430 ±2.4	0.450 ±1.6	0.01*
Tapped density	0.480 ±1.6	0.500 ±1.6	0.515 ±1.2	0.01*
Carr Index	16	14	14	0.02*
Hausner Ratio	1.2	1.16	1.14	0.00

The values of the same row with different superscript differ significantly ($p < 0.05$)

This matches the findings of Shrestha *et al.* (2007). When the input temperature was increased from 150 °C to 170 °C, the product yield of the samples fell on average. This reduction could be attributed to the pink guava droplets clinging to the hot surface area of the spray drying chamber (Sahin-Nadeem *et al.* 2013).

Moisture content

When the inlet air temperature is too high the temperature of the particle increases quickly above glass transition, and the droplets stick on the hot surface of the drying chamber. On the contrary, when the difference is minimal the powder sticks in the hot surface more easily because it is not completely dry and caused a lower yield.As maltodextrin level increased from 10 to 20%, the moisture content of sample decreased from 0.9 and 0.33% as shown in (table 2). Abadio *et al.* (2004) observed that on increasing the level of maltodextrin from 10 to 15% (w/v), there was decrease in moisture content in final pineapple juice powder.

At a constant feed flow rate, the moisture content of spray-dried powders decreased with the increased inlet and outlet air temperature. The addition of Maltodextrin concentration to the feed before Spray drying increased the total solid content and reduced the amount of water for evaporation, resulting in decreased moisture content of the powder. Similar results show that watermelon contains 2.78% (Vidya *et al.* 2016), and spray-dried gooseberry powder 3.55% (Thankitsunthorn *et al.* 2009). In a spray drying system, the water content of the feed affects the final moisture content of the product (Halliday and Walker 2001). With higher initial water content in the feed, the final product will also have higher moisture content.

At higher inlet air temperatures, there was a significant change found in moisture content due to the higher temperature gradient between the atomized feed and the drying air, causing rapid water vaporization with a greater rate of heat transfer, ultimately leading to generating powders with lower moisture content (Kha *et al.* 2010). According to Goula *et al.* (2008) data, an increase in air inlet temperature causes a decrease in moisture content. According to Shrestha *et al.* (2007), higher MD concentrations had a positive influence on the moisture trend of spray-dried powder by reducing the quantity of water evaporation.

Hygroscopicity

Hygroscopicity of Guava and Gooseberry juice powder ranged from 12 and 42 g of water/100 g of dry matter, similar to the 20.39-34.04 g of water/100 g of dry matter reported for spray dried tamarind pulp (Muzaffar and Kumar *et al.* 2015), but slightly higher than the 14.46 and 20.68 g of water/100 g of dry matter reported for spray dried beetroot juice (Bazaria and Kumar *et al.* 2016). Tonon *et al.* (2008) explained that the lower the particle moisture content, the higher their hygroscopicity because due to a greater moisture gradient at low moisture content, powder has a greater tendency to absorb the moisture content. Feed rate was also one of the important parameters which affected the hygroscopicity of the powder.

Hygroscopicity depends on the compositions (low molecular weight sugar, organic acid, and moisture content) of the product and also the concentrations of drying agents (Noreña *et al.* 2016). Water adsorption measured as hygroscopicity is a critical factor in powdered products since the presence of water can influence the deterioration of the vitamins and phenolic compounds and powder properties such as flowability. Ferrari *et al.* (2012) reported that the hygroscopicity values were inversely proportional to the powder moisture content, due to the high-water concentration gradient between the product and the surrounding air. An increase in Inlet air temperature and maltodextrin concentration and a decrease in Maltodextrin DE leads to higher powder T_g and as a result lower hygroscopicity. This observation is similar to that reported by other researchers (Jaya Das *et al.* 2004).

Dissolution test

The dissolution test measures the time requires to dissolve the powder in water. The time is determined in the vortex without stirring. Table 2 revealed that the dissolution times for the Guava and Gooseberry powder dried at 150 °C were 30, 40, 40 minutes for 10, 15, and 20% respectively. All the samples were completely dissolved in water after the mixture was allowed to be mechanically agitated using a magnetic stirrer. The time taken from the dissolution test can be related to the moisture content of the powder.

The higher the moisture content of the final powder, the easier that particular powder to reconstitute in water. Therefore, at lower inlet temperature the evaporation rate is slower, producing powder with higher moisture content. Higher the moisture content of the powder results in a higher tendency toward agglomeration the powder (Chengeni and Ghobadian *et al.* 2006).

Bulk density

Bulk density can be defined as the powder's apparent density that is related to a volume called the bulk volume, therefore to determine the value of a bulk density of a specific powder, the bulk volume occupied by that powder has to be measured by a graduated cylinder. (Table 2) shows that maltodextrin concentration does not influence the bulk density. The bulk density of the samples ranged from 0.4 to 0.45 g/ml for 10-20 %. spray dried amla and gac powders also showed no significant difference in their bulk density when added to different concentrations of maltodextrin (Kha *et al.* 2010). In contrast, Goula and Adamopoulos (2010) found that spray-dried orange powders of lower bulk density were produced at a higher concentration of maltodextrin. The effect was due to the properties of maltodextrin, which minimizes thermoplastic particles from sticking. The bulk density of spray-dried Bintangor powder with 10% to 20% maltodextrin added decreased to 0.45 to 0.48 g/ml respectively. From the findings of other studies, it was found that increasing inlet temperature causes the bulk density of the spray-dried powder to decrease (Cai and Corke *et al.* 2000). This reduction was due to evaporation rates being faster and products drying to a more porous or fragmented structure when the inlet temperature increases (Goula and Adamopoulos 2005).

Tapped density

The results showed that increasing the maltodextrin concentration led to the reduction of tapped density from 0.48 to 0.51(g/ml). Similar values are found in pineapple 0.43 (g/ml), Carambola 0.40 (g/ml), and watermelon 0.56 (g/ml) (Kad *et al.* 2016). Samples containing fine particles significantly showed higher tapped density and less porosity than those without fine particles, and this effect is probably due to the occupation of the pores between the large particles by the fine particles (Botrel *et al.* 2014).

Carr index

The Carr index of the Encapsulated Guava and Gooseberry juice powder was obtained as 16 to 14(%) which shows good flowability for 15 and 20%. Similar results were found for pineapple is 18.49% which shows fair flowability (Kad *et al.* 2016).

Hausner ratio

The Hausner ratio can be used as a measure of the transient from free flow to adhesion of the powders. This makes it possible to predict relatively stable operating and processing points in terms of particle size and relative humidity. The Hausner ratio is measured to determine the compressibility and free flow of powders. The importance of the Hausner index is more related to the properties of handling and transport than the static state of the powders.

In this study, the cohesiveness value of the produced Guava and gooseberry juice powder was between 1.2 to 1.16, which indicates the relatively good flow behavior of the samples. Increasing the concentration of maltodextrin did not influence the degree of cohesion significantly.

Colour profile

The lightness (L*,+), redness (a*,+), and yellowness (b*,+) of fresh Guava and Gooseberry juice powderwith different maltodextrin concentrations are given in table (3).Because MD is usually white, increased MD concentrations were the main cause of increased powder lightness. Other researchers have discovered similar values in spray dried gac powder (Kha *et al.* 2010), spray dried watermelon powder (Quek *et al.* 2007), and spray dried guava powder (Chopda and Barrett *et al.* 2001). The brightness, redness, and yellowness of the Guava and Gooseberry powder solutions were strongly impacted by MD content as well as inlet air temperature. Higher degree of lightness of spray dried powder at higher inlet temperature indicates that the pigments have been lost due to oxidation (Sousa *et al.* 2008).

Functional properties

Table 3 Colour profile of encapsulated juice powder

Colour	L*	a*	b*
10 % MD Concentration	75.78 ± 0.04	-1.08 ± 0.05	12.2 ± 0.07
15 % MD Concentration	86.51 ± 0.008	-2.05 ± 0.02	17.2 ± 0.01
20 % MF Concentration	80.7 ± 0.02	0.27 ± 0.03	22.7 ± 0.06

Values represent mean ± standard deviation

Table 4 Functional properties

Functional properties	10%MD	15%MD	20%MD	P Value
Total phenol content	62 mg	70.44 mg	88.22 mg	0.01*
DPPH radical scavenging activity	18%	20.82%	26.21%	0.01*

*Significant at 1% p < 0.05

Total phenol content

The results were obtained by using the Calibration Curve and were expressed as Gallic acid equivalents per 1 g spray-dried Guava and Gooseberry juice powder (mg GAE/g Guava and Gooseberry powder. The total phenol content of the spray-dried Guava and Gooseberry juice powder ranged between 62 and 88.22 mg/100 g. The total phenol content of spray-dried pineapple fruit juice powder was 40.5 mg/100g (Selvamuthukumaran and Khanum 2014) and spray-dried grapefruit juice powder was 46.9mg/100 g (Selvamuthukumaran and Khanum 2014). Similar results were observed by Mishra *et al.* (2014) for spray-dried amla juice powder and by Wariiyah and Riyanto (2016) for spray dried aloe vera juice powder. Spray-dried mango powders had a total phenol content that ranged from 50.62 to 96.14 mg GAE per g dry powder (Siacor *et al.* 2020). Mishra *et al.* (2014) showed that total Phenol Content increased in amla powder when the temperature increased from 125 to 175 °C after which phenolic content decreased.

DPPH radical – scavenging activity

Radical Scavenging activity is an important property due to the inhibition of free radicals in foods and biological systems and it is an indication of antioxidant capacity. The radical scavenging activity (%) of methanol extract (50 /ml) of encapsulated Guava and Gooseberry juice powder was found at 18 % and 26.21%. Similarly, the DPPH inhibition of Arenga pinnata juice powder ranged from 26.81 to 28.74% inhibition (Abdurrahman AdeleyeBadmus *et al.* 2016). Naknean and Meenune 2011 reported the DPPH radical Scavenging activity of thermally heated palm sap syrup ranged from 13.27 μmol Trolox equivalent (TE) to 18.49 of the sample, while Aeimsard *et al.* (2015) reported the DPPH inhibition of palm sugar at 43.33%. The antioxidant activity of phenolic compounds is related to free radical scavenging and hydrogen donation ability. This decrease may be attributed due to decreases in pumpkin juice concentration in the feed mixture. The increases in inlet air temperature which also caused decreased DPPH radical scavenging activity may be due to the degradation of some bioactive compounds. The negative correlation of air inlet temperature and maltodextrin concentration with DPPH radical scavenging activity in terms of antioxidant activity is in agreement with the results for Gac fruit powder (Kha *et al.* 2010). Overall, on increasing the inlet temperature from 125 °C to 200 °C a significant decrease in DPPH radical scavenging activity was observed. Similar results were observed in spray-dried Gac juice powder by Kha *et al.* (2010). The possible explanation for the low free radical scavenging activity may be because the exposure to higher temperatures adversely affected the structure of phenolic causing its break down and/or synthesis into different forms. An increase in the maltodextrin concentration which itself has no free radical scavenging activity resulted in lower DPPH scavenging activity.

Vitamin C content

The Vitamin C content of Spray dried juice powder varied from 200 and 675 mg/100g as shown in (Table 5). The Guava and Gooseberry juice contain 680 mg/100 g. With an increase in additive concentration, the ascorbic acid content increased. The ascorbic acid is well-encapsulated and less affected by exposure to a higher temperature when there are more additives present (Mohanty *et al.* 2021). The encapsulated Guava and Gooseberry juice powder shows highly significant difference (P<0.05), spray dried guava powder made with maltodextrin was 114.79mg/100g (Chopda and Barret *et al.* 2001), spray dried pomegranate juice powder made with maltodextrin was 11.52 mg/100 g (Muzaffar *et al.* 2016).

Table 5 Vitamin C content of Encapsulated juice powder

Maltodextrin (MD) concentration	Vitamin C content in juice before encapsulation	Vitamin C content after encapsulation	P Value
10% Maltodextrin	680 g/mg	200 g/mg	0.00*
15% Maltodextrin		450 g/mg	0.00*
20% Maltodextrin		675 g/mg	0.00*

*Significant at 1% level at P < 0.01

Vitamin C content decreased as the concentration of MD increased because the overall solid content of the sample increased. Similar results were found for Sea buckthorn fruit juice powder (Selvamuthukumaran and Khanum 2014) and spray dried guava juice powder (Patil *et al.* 2014).

High percentage of MD with high temperature had lower amount of vitamin C as compared to lower percentage of MD with lower temperature. Vitamin C is very sensitive to temperature and heat (Rodriguez – Her-nandez *et al.* 2005) as evidenced by the decreases in vitamin C content as inlet air temperature increased. The loss in vitamin C content during drying involves oxidation and hydrolysis. The ascorbic acid is oxidized to dehydroascorbic acid, followed by hydrolysis to 2,3-diketogulonic acid and further oxidation and polymerization to form a wide range of other nutritionally inactive products (Gregory III 2008).

Besides the effect of high temperature on the loss of vitamin C, the loss can occur by chemical degradation during preparation step. Because of the high solubility of vitamin C in aqueous solution, there was potential for significant losses by leaching from freshly cut fruit. The loss can also occur during storage and handling (Gregory III 2008).

Encapsulation ratio before and after encapsulation

Encapsulation efficiency is an important parameter which influences the amount of active compound remaining on the surface of the powders, hence it determines the stability of the encapsulated active compound. Encapsulation efficiency indicates the capability of the carrier material to encapsulate the target molecule. According to Mohammed *et al.* (2020) the characteristics of the coating agent, inlet temperature, air flow rate, and feed emulsion characteristics all have an impact on encapsulation efficiency. Encapsulation Efficiency varied from 48.8 to 80% for 10 ,15 and 20% maltodextrin concentration respectively (Table 6).

Table 6 Encapsulation efficiency

Maltodextrin concentration	Before encapsulation	After encapsulation	P Value
10%	150	48.8	0.00
15%	180	60	0.01*
20%	200	80	0.00

*Significant at 1% level at P < 0.01

The results (Table 6) showed that different maltodextrin concentrations had a significant difference (p<0.05) on the percentage of encapsulation efficiency.15% and 20% maltodextrin samples had the highest encapsulation efficiencies 48.8 and 80 % respectively and the lowest encapsulation efficiency related to 10% maltodextrin. Increasing the concentration of maltodextrin in the wall of Guava and Gooseberry juice powder increased the encapsulation efficiency. Both temperature as well as the wall material had a significant effect on the encapsulation efficiency (Murali *et al.* 2014). Different maltodextrin concentrations had a significant impact on the percentage of microencapsulation efficiency, according to the findings of (Tabasi *et al.* 2021).

CONCLUSION

The development of Encapsulated juice powder is nutritionally loaded with vitamin C content and has good physical and functional properties, according to the findings of this study. However, 60 g of guava and 40 g of gooseberry are used to make Encapsulated Guava and Gooseberry juice. Significant changes in physiochemical and functional properties of the samples produced by varied maltodextrin concentrations were identified in both inlet air temperature and maltodextrin concentration. The maltodextrin concentration and intake temperature had a substantial impact on moisture content, colour features, and EE. At an inlet temperature of 150 °C and a maltodextrin concentration of 20%, the encapsulated guava and gooseberry juice powder was successful in preserving moisture content, colour attributes, vitamin C were determined. Thus, we can conclude that encapsulation using spray drying and increased maltodextrin concentration, increases the encapsulation efficiency ratio.

Acknowledgement

The study entitled has been approved by the Independent human ethics committee (IHEC) – (Protocol No. SDNBVC/HSC/IHEC/2021/01) and supported by Shrimathi Devkunvar Nanalal Bhatt Vaishnav College for Women, Affiliated to Madras University, Chrompet, India.

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