



P-ISSN: 2349-8528

E-ISSN: 2321-4902

[www.chemijournal.com](http://www.chemijournal.com)

IJCS 2020; 8(6): 2449-2452

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Received: 04-09-2020

Accepted: 12-11-2020

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## Influence of maltodextrin on the physical attributes of microencapsulated avocado (*Persea americana* Mill.) powder obtained through co-current spray drier

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**DOI:** <https://doi.org/10.22271/chemi.2020.v8.i6ai.11140>

### Abstract

Spray drying is the highly accepted and widely followed technique for encapsulation of bioactive compounds. The efficiency of encapsulation is highly dependent on the encapsulating agent. This experiment was conducted in a view to check the suitability of different levels of maltodextrin as an encapsulating agent in spray drying of avocado powder. Spray drying at different maltodextrin levels i.e., 5%, 10%, 15%, and 20% were performed to evaluate the physical attributes of spray-dried avocado powder. Results showed that higher levels of maltodextrin favoured in achieving stability by minimizing the residual moisture levels and water Activity. Moreover, it significantly induced the free-flowing attributes of spray-dried powder.

**Keywords:** Spray drying, micro-encapsulation, maltodextrin, physical attributes

### Introduction

The avocado (*Persea Americana* Mill.) popularly known as butter fruit belongs to the Lauraceae. It is native to Mexico and Central America and well adapted to tropical and subtropical areas. It has received worldwide acceptance due to high nutritional density which includes 65-80% water, 1% sugar, and about 1-4% protein and nearly oil 3-30%. It is a rich source of vitamin B and moderate levels of vitamins A and D (Purselove, 1968) [17]. In addition, it contains a high portion of monounsaturated fat which speeds up the basal metabolic rate, as compared with saturated fat. The oleic acid in high proportion contributes to the monounsaturated fat, which in turn reduces the blood levels of the low-density lipoprotein (LDL) cholesterol that contributes to heart disease. High fiber content will help in maintaining a healthy digestive tract which can prevent constipation, encourage regular bowel movement with effective detoxification which also aids in maintaining good body mass with reduced occurrence of colon cancer (Fulgoni *et al.*, 2013) [8]. The bioactive compounds, such as flavonoids, pigments, phytoosterols, and phenolic compounds are the important components that contribute to the antioxidants activity of pulp. Avocados are seasonal and typical climacteric fruits that lose their shelf life within a short span of time. Therefore, processing it into a stable product is more feasible and at most necessary. Most of the preservation methodologies involve a high-temperature process which results in the destruction of bioactive compounds and heat-sensitive nutrients. Therefore, spray drying using encapsulating agents will have offered great protection to these compounds from thermal shock and aid in producing bioactive rich of fruit power. Hence, efforts were made to understand the suitable level of maltodextrin as an encapsulating agent and their influence on the powder's physical attributes.

### Materials and Methods

#### Materials

Fruits of uniform size and maturity were hand-picked individually at the Central Horticultural Experimental Station (CHES), Chettalli which are free from any visible damages. Further, they were placed in corrugated fiberboard boxes and was brought to ICAR-IIHR, Bengaluru.

### Sample Preparation

The firm ripe fruits were taken out and washed with clean water, cut into halves and the seed with coat attached were removed and the pulp was scooped out easily. Avocado fruit juice was prepared by blending the pulp using portable water in the ratio of 1: 1.5. The juice was filtered using the muslin cloth to minimize the chances of blocking the atomizer of the spray dryer. Later, the required quantity of citric acid, maltodextrin was added and blended uniformly using the homogenizer.

### Food additives

The citric acid, soya lecithin, and Maltodextrin used in the experiment were all of the food-grade material. In this study maltodextrin having DE = 10 was used.

### Spray drying

The spray drying was performed at AICRP on Postharvest Technology, GKVK, UAS, Bengaluru. The co-current pilot-scale spray dryer (R&D, Milk Tech. Engineers, Manufacturer & Supplier Pvt. Ltd, India) equipped with a 1 mm nozzle size of and 4 kg/ cm<sup>2</sup> air pressure was used in this experiment.

### Experimental details

The experiment was designed and carried at the Division of Post-Harvest Technology & Agricultural Engineering, ICAR-Indian Institute of Horticultural Research (IIHR), Hessaraghatta, Bengaluru, and College of Horticulture, Bengaluru, (University of Horticultural Sciences, Bagalkot), Karnataka, during 2016 – 2017. Spray drying variables such as inlet drying temperature of 160 °C and feed flow at 10 ml/min was maintained constant throughout the experiment. The maltodextrin as a carrier was varied at 5%, 10%, 15% and 20%. After completion of the spray drying the samples were immediately collected from the product collection vessel and packed in aluminum laminated pouches until further analysis. All the treatments were replicated five times.

### Physical Properties

#### Moisture (%)

Moisture content was determined using an electronic moisture analyzer, Sartorius MA 35. 5g of powder was dried at 130 °C and the moisture was expressed in terms of percent.

#### Water Activity

The water activity was determined using an electric water activity meter, Rotronic Hydrolab, UK, at 25 °C. Water activity is expressed as the ratio of partial vapor pressure of water in product to the partial vapor pressure of pure water at the same temperature.

#### Colour (L a b values)

L a b color values were determined using Lovibond color meter (Lovibond RT300, Portable spectrophotometer, Tintometer Limited, Salisbury, UK) fitted with 8 mm aperture and the instrument was adjusted at 10° observers and D65 primary illuminant was used. Calibration was done using black and white tiles. The Color was expressed in Lovibond units L\* which refer to the lightness of the product which will range from darkness-lightness (0-100), a\* refer to greenness – redness (-120 to 120) where negative values indicate greenness and positive indicate redness. Similarly, b\* values refer to blueness - yellowness (-120 to 120) where negative values indicate blueness and positive values indicate

yellowness. The powder was placed in special cuvettes under the lens of the color reader.

### Wettability

The wettability was evaluated as per the method described by Vissotto *et al.* (2010) [21] and expressed in terms of the time required for one gram of powder deposited on the liquid surface to become completely submerged in 400 ml of distilled water at 25°C.

### Bulk Density

Bulk density (g/ml) was determined by gently pouring 20 g of powder into 100 ml of the graduated cylinder and was calculated as the ratio of the weight of the sample in the cylinder to the volume occupied.

### Tap density

Tap density (g/ml) was determined by gently pouring 20 g of powder into a 100 ml graduated cylinder followed by tapping 100 times. The ratio of powder mass and the volume occupied in the cylinder was used to determine the tap density.

### Hausner ratio

Hausner ratio was determined as the ratio of tap density and bulk density.

### Carr's index

Carr's index refers to the compressibility of powder which is obtained using the below formula.

$$\text{Carr's index: } 100 * \frac{(\text{Tapped Density} - \text{Bulk Density})}{(\text{Tapped Density})}$$

### Powder Yield (%)

The per cent yield of spray-dried was expressed as the ratio of powder obtained to the weight of feed mixture consumed on a fresh weight basis.

$$\text{Powder Yield (\%)} = \frac{\text{Weight of spray dried powder obtained (g)}}{\text{Weight of feed mixture subjected for spray drying (g)}} \times 100$$

### Statistical Analysis

All the treatments were replicated five times. Data obtained for various attributes were subjected to statistical analysis using "Web Agri Stat Package 2" of ICAR Research Complex, Goa. 'F' test at p = 0.01 was performed to assess the level of significance. Critical difference values were calculated where the 'F' test was significant.

## Results and Discussion

### Moisture

The moisture content represents the water composition in a food system and its one of the primary attribute of dehydrated products and so for the powder stability during storage (Phisut, 2012) [14]. The moisture content in the spray-dried avocado powder varied from 1.80 to 2.64% (Table 2). The results indicate that at constant temperature and feed flow the moisture content decreased as the concentration of the added maltodextrin increased in the feed solution. The total solids in the feed solution before atomization will have an influence on the final moisture content in the finished product (Abadio *et al.*, 2004; Caliskan and Dirim, 2013; Quek *et al.*, 2007; Patil *et al.*, 2014) [1, 4, 18, 13]. In addition to it, higher levels of maltodextrin aided in obtaining the free-flowing attributes in powders without causing stickiness due to low moisture content.

### Water Activity

Water activity indicates the available free water for various biochemical reactions occurring in the powder. It can be defined as the ratio of vapour pressure of water in food to vapour pressure of pure water at the same temperature (Fennema, 1996) [7]. The water activity of spray-dried powder was significantly different among varying levels of maltodextrin concentration. The water activity of all powders produced was in the acceptable range *i.e.*, 0.16 to 0.23 (Table 2). It was found that as the maltodextrin concentration increased, the moisture content decreased in the powder. This is due to a reason that increase in the total solids in feed affected the drying rate positively, which resulted in producing powders with a low water activity (Porrarud and Pranee, 2007) [15]. The food with water activity range between 0.20 - 0.40 is considered to be stable from microbiologically and biochemically stable (Quek *et al.*, 2007; Marques *et al.*, 2007) [18, 10]

### Colour

**L values:** L values of spray-dried avocado powder varied significantly among the different levels of maltodextrin. The lightness of the powder ranged between 60.16 to 71.87 (Table 2). It was found that increased levels of maltodextrin increased the L values proportionally. With respect to a sensory appeal, optimal maltodextrin concentration levels are always advisable. Higher levels of maltodextrin will cause dilution in the colour which may result in lighter and brighter powder colour. The results were in confirmation with the following, Caliskan and Dirim, 2013; Nadeem *et al.*, 2011 Ahmed *et al.*, 2010; Sahin-Nadeem *et al.*, 2013. [4, 11, 2, 19]

### a values

The values of a indicate the degree of greenness (-a) and redness (+a) of the product. As the pulp of avocado is greenish-yellow the same is expected in the spray-dried powder. The a values made a shift from negative to positive *i.e.*, -1.14 to 3.22 (Table 2) as the concentration of the maltodextrin increased in the feed from 5% to 20%. It was noticed that the degree of greenness was highly affected by the Maltodextrin and the same was reported by Dantas *et al.*, 2018 [5].

### b values

The b values indicate the degree of blueness (-b) and yellowness (+b) of the product. All the samples displayed positives b\* values, indicating the presence of yellowness in the powder. The +b values ranged from 30.22 to 23.29 (Table 2) which indicates the loss of yellowness in the powder as the increased levels of maltodextrin. Higher levels of maltodextrin in the feed is a reason for discoloration which indicates loss of natural colour and further which might affect the marketability (Dutta *et al.*, 2006) [6].

### Chroma

Chroma values represent the intensity of the colour. It can be seen from table. 2 that as the concentration of the maltodextrin increased the intensity of the colour decreased from 30.25 to 23.52 (Table 2). which is due to the reason that higher levels of maltodextrin in the feed will increase the degree of brightness and the same will be the result in the finished product.

### Hue Angle

The values for hue angle varied from 91.51 to 82.12 (Table

2). Hue angle refers to differences of a certain colour (Pathare *et al.*, 2013) [12]. There was a gradual decrease in the values when the concentration of maltodextrin varied from 5% to 20%. A higher level of maltodextrin masked the colour of the powder and shifted the colour of powder from light green to yellow indicating a decrease in the intensity of colour at higher levels of maltodextrin.

### Wettability

The values for wettability ranged from 140.60 to 59.00 s (Table 2). The maltodextrin just not being a very good encapsulating agent but also imparts greater physical attributes to spray-dried powders. An increase in the levels of maltodextrin favored the wettability. The lower the wettability values, the greater the rehydration or reconstitution properties of the powder. Indicating the negative correlation with wettability. The same was found and reported by Caliskan and Dirim, 2013 and Bhandari *et al.*, 1993 [4, 3].

**Table 1:** Moisture, Water activity and Colour (L a b) of avocado fruit pulp

Parameters		Values
Moisture		73.56
Water Activity		0.691
Colour	L	49.31
	a	-3.4
	b	34.93

### Bulk Density and Tap density

Bulk density of the powder is an important attribute that play a major role in occupying the space in the packaging material. Bulk density ranged from 0.52 to 0.40 and tap density from 0.72 to 0.60. (Table. 2). Bulk density and tap density of spray-dried avocado powder showed a decreasing trend with an increase in maltodextrin concentration. This is due to the reason that higher levels of maltodextrin minimize the agglomeration of thermoplastic particles (Goula and Adamopoulos, 2010) [9].

### Hausner ratio and Carr's index

Hausner ratio and Carr's index will indicate the attributes such as cohesiveness and flowability of the powder respectively. The standard value for Carr's index and Hausner ratio, to detect good flowability, the compressibility index must be within 15% and the Hausner ratio within 1. From table 2. it is found that the values for Carr index and the Hausner ratio for the spray-dried avocado powder increased with the increase in maltodextrin concentration. The Hausner ratio and Carr's index for the spray-dried avocado powder ranged from 1.39 - 1.50 and 27.82 - 33.41 respectively. Which indicated the poor flowability attributes which may be due to high fat content in powder.

### Powder Yield

The process yield of spray-dried avocado powder varied significantly among different with the concentration of maltodextrin in the feed solution. The process yield ranged from 6.53% to 19.33% (Table 2). The yield at 5% was significantly the least due to stickiness in the powder due to the melting of the powder and wall cohesion. whereas maltodextrin at 10%, 15%, and 20% elevated the glass transition temperature of the powders and contributed towards high yield and free-flowing characters. The same was reported by Porrás-Saavedra *et al.* (2015) [16] and Suzihaque *et al.* (2015) [20] in pineapple powder.

**Table 2:** Influence of maltodextrin Levels on the physical properties of spray dried avocado powder.

Treatments (Maltodextrin Levels)	Moisture Content (%)	Water activity ( <i>a<sub>w</sub></i> )	Colour values					Wettability (s)	Bulk density (g/ml)	Tap density (g/ml)	Hausner ratio	Carr's Index	Powder yield (%)
			L	a	b	C	H						
5 %	2.64 <sup>a</sup>	0.23 <sup>a</sup>	60.16 <sup>d</sup>	-1.14 <sup>b</sup>	30.22 <sup>a</sup>	30.25 <sup>a</sup>	91.51 <sup>a</sup>	140.60 <sup>a</sup>	0.52 <sup>a</sup>	0.72 <sup>a</sup>	1.39 <sup>d</sup>	27.82 <sup>d</sup>	6.53 <sup>d</sup>
10 %	2.14 <sup>b</sup>	0.20 <sup>b</sup>	64.85 <sup>c</sup>	0.49 <sup>c</sup>	27.53 <sup>b</sup>	27.53 <sup>b</sup>	88.98 <sup>b</sup>	98.20 <sup>b</sup>	0.48 <sup>b</sup>	0.68 <sup>b</sup>	1.42 <sup>c</sup>	29.71 <sup>c</sup>	12.35 <sup>c</sup>
15 %	2.28 <sup>b</sup>	0.20 <sup>b</sup>	69.05 <sup>b</sup>	1.29 <sup>b</sup>	24.51 <sup>c</sup>	24.54 <sup>c</sup>	86.99 <sup>c</sup>	73.60 <sup>c</sup>	0.43 <sup>c</sup>	0.63 <sup>c</sup>	1.47 <sup>b</sup>	31.80 <sup>b</sup>	16.89 <sup>b</sup>
20 %	1.80 <sup>c</sup>	0.16 <sup>c</sup>	71.87 <sup>a</sup>	3.22 <sup>a</sup>	23.29 <sup>d</sup>	23.52 <sup>d</sup>	82.12 <sup>d</sup>	59.00 <sup>d</sup>	0.40 <sup>d</sup>	0.60 <sup>d</sup>	1.50 <sup>a</sup>	33.41 <sup>a</sup>	19.33 <sup>a</sup>
Mean	2.21	0.20	66.47	1.53	26.39	26.45	87.40	92.85	0.46	0.66	1.44	30.70	13.77
S. Em±	0.06	0.01	0.34	0.06	0.25	0.25	0.25	0.85	0.01	0.01	0.01	0.34	0.23
C. D. at 5%	0.16	0.02	1.140	0.18	0.75	0.75	0.76	2.53	0.02	0.02	0.02	1.02	0.69

## Conclusion

Maltodextrin as a carrier agent had a significant effect on the physical attributes of microencapsulated avocado powder. An increase in the concentration of maltodextrin improved stability by favoring lower residual Moisture Content and water activity. Though increased levels of maltodextrin resulted in higher process yields and induced free-flowing attributes, the degradation of colour (greenness) after a certain concentration was reported which is due to increase in total solids in feed which simultaneously increased the outlet temperature which determined the product quality. Therefore, intermediate levels of encapsulating agent were more feasible.

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