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Studies on storage stability of spray dried muskmelon fruit powder

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Abstract

Muskmelon fruit powder was prepared by adding optimized level of food additives to the fruit pulp and dried by using spray drier. The storage stability of the muskmelon fruit powder was studied by packing in three different packaging materials and stored at room and refrigerated conditions. Results of the storage studies showed that a gradual increasing trend in the moisture content, pH and reducing sugar and a slight decrease in the contents acidity, total sugar, ascorbic acid, β - carotene, total antioxidant activity and colour values were observed in all the samples throughout the storage period of 180 days at room (29 ± 5 °C) and refrigerated temperatures (5 ± 1 °C). Organoleptic evaluation studies showed that the overall acceptability of the processed product was slightly changed at the end of six months.

Keywords: Muskmelon, spray drying, nutrient content, storage quality, packaging organoleptic evaluation of powder.

Introduction

Muskmelon (*Cucumismelo* L.) commonly called as cantaloupe is a member of Cucurbitaceae family. Consumer preference for this fruit is determined largely by its sweetness, flavor or aroma, texture and more recently as a rich source of phytonutrients. The fruit crop is cultivated widely by farmers in our country particularly during the summer season (April to July). The main areas of muskmelon cultivation are Punjab, Tamil Nadu, Lucknow, Safeda, Uttar Pradesh, Maharashtra, and Andhra Pradesh. In Tamilnadu, muskmelon is mostly grown in Tindivanam, Kanchipuram, Dharmapuri, Villupuram, Pudukottai and Thenidistricts. Muskmelon flesh contains 3.5 g carbohydrates, 0.3 g protein, 0.2 g fat, 3420 IU vitamin A, 26.0 mg ascorbic acid, 23 mg calcium, 1.4 mg iron, 14.0 mg phosphorus and 341 mg potassium. Muskmelon is relished as a desert fruit, low in calories and fats or cholesterol and is an excellent source of vitamin A and C and minerals. In melons there are many phytochemicals that may have a vast array of potential health benefits (Venkatesan *et al.*, 2016) [14]. Muskmelon fruits, because of their high moisture content and nutrients availability and favorable pH are more vulnerable to the infestation of pathogenic fungi, which in addition to fungal rots, makes the fruits unsound for human. In order to give maximum returns to farmers and to curtail post harvest losses during glut season, there is dire need to seek for an alternative simple and cost-efficient process to extend the shelf - life of muskmelon. As muskmelon fruit contain important phenolic phytochemicals and other essential nutrients and preserving its pulp will meet the demand of market throughout the year. Processing of muskmelon fruit will not only be helpful in lowering the post harvest losses but will enhance the livelihood of fruit growers, commerce and the economy of the nation. Research needs to be done to explore the possibility of employing processing of muskmelon fruit to minimize the losses and to make them available for consumption in the off - season. Therefore, the present research work was undertaken to process the muskmelon fruit into powder form and also to study its stability during storage for commercialisation.

Materials and method

Processing of muskmelon fruit powder: The selected musk melon fruits (local variety) were washed under running tap water and the inedible portion was peeled off by using a stainless steel knife. The peeled fruit was halved into two portions and its seeds were scooped out.

The fruit was cut into small pieces and pulped in the mixer. The pulp was filtered through a sterilized nylon net. The TSS content of the fruit pulp was adjusted to 25° brix by adding maltodextrin and calcium stearate at a level of 0.1 per cent was added to prevent caking during storage. The optimized parameters for the production of muskmelon fruit powder by using spray drier was inlet air temperature -180 °C and feed rate -25 ml/minute. The process for the production of muskmelon fruit powder by using spray drier is presented in the flowchart- I.

Flow Chart I: Processing of muskmelon fruit powder

Storage stability of muskmelon fruit powder:

The processed musk melon fruit powder was packed in metalized polypropylene (MPP) bags, polypropylene (PP) bags with 300 gauge thickness and aluminum foil pouches (AF) and stored at room temperature (32 ± 2 °C) and refrigeration temperature (4 ± 1 °C) for storage. To study the storage behavior of the thermally processed musk melon fruit powder, the changes in the chemical composition and organoleptic characteristics were analyzed once in 30 days during the storage period of six months. Whereas microbial load was analyzed before and after storage of processed fruit powder. The chemical characteristics viz., moisture, pH, acidity, TSS, reducing sugar, total sugar, ascorbic acid, β - carotene and total antioxidant activity and colour intensity by using analytical procedure AOAC (1995) [1]. The microbial load of the stored sample was enumerated by the method described by Istawankiss (1984) [5]. Organoleptic evaluation of the prepared samples was done by using nine point hedonic scale of ten untrained judges (ASTM, 1968) [3].

Data Analysis

The data obtained were subjected to statistical analysis to find out the impact of packaging materials and storage period on the quality of the prepared muskmelon fruit powder. Factorial Completely Randomised Design (FCRD) was applied for the analysis of the study as described by Rangaswamy (1995) [9].

Results and discussion

Physico - chemical characteristics of spray dried muskmelon fruit powder

The physico - chemical characteristics of selected spray dried muskmelon fruit powder was analyzed and presented in Table

- 1. The prepared fruit powder was orange with whitish in colour, natural muskmelon flavour and found highly acceptable in taste. The chemical characteristics of freshly prepared spray dried muskmelon fruit powder contained moisture - 4.19 per cent, pH - 5.39, acidity - 0.1 per cent, TSS - 55 °brix, total sugar - 25.07, reducing sugar - 11.82 per cent, β - carotene - 988.99 $\mu\text{g}/100$ g, ascorbic acid - 97.63 mg/100g, total antioxidant activity - 14.34 mg/g and colour values L^* - 95.92, a^* - 4.17 and b^* - 22.12.

Solval *et al.* (2012) [13] analyzed the chemical composition of spray dried cantaloupe juice powder. They found that the powder contained moisture - 4.19 ± 0.18 , vitamin C - 91.85 ± 5.23 , β - carotene - 127.94 ± 16.82 and colour values L^* - 89.06 ± 0.54 , a^* - 3.35 ± 0.29 and b^* - 22.71 ± 0.74 .

The physico - chemical characteristics of the spray dried biocolour from beetroot was analyzed by Vennila and John Kennedy (2013) [15]. The biocolour was highly soluble in water (100%) with no sedimentation. The chemical characteristics were moisture - 2.07 per cent, pH - 4.20, total antioxidants - 16.36 mg /g and colour intensity - L^* , a^* and b^* - 88.66, 4.57 and 2.13 respectively.

Storage behavior of spray dried muskmelon fruit powder Chemical changes of the muskmelon fruit powder

The chemical constituents such as moisture, acidity, pH, total soluble solids (TSS), total sugar, reducing sugar, β - carotene, ascorbic acid, total antioxidant activity, and colour values were analyzed at regular intervals (once in 30 days) during the storage of 180 days. Each chemical component of the stored sample was changed as the storage period increases irrespective of the packaging materials and storage conditions used for the study.

Moisture

The moisture content of the spray dried muskmelon fruit powder was given in Table - 2 A gradual increase in moisture content was observed in all the samples packed in different packaging materials and storage conditions during the study period. The packaging material showed its influence on the moisture pick up of the samples during storage as the storage period extended. The initial moisture content was 4.19 which had changed to 4.87 (P_1), 4.69 (P_2) and 4.47 (P_3) per cent in room temperature (R_1) and 4.56 (P_1), 4.52 (P_2) and 4.39 (P_3) per cent in refrigeration temperature (R_2) at the end of storage period (180 days). A slight variation was observed throughout the study period between packaging materials and storage conditions.

As noted in the fruit powder stored at room temperature recorded maximum increase in the moisture content than refrigeration temperature as the storage periods increases. Among the packaging materials selected for the study sample packed in MPP recorded less moisture content followed by P_2 and P_1 in the stored samples of both the storage condition.

Statistical analysis of the data (spray dried muskmelon fruit powder) showed a highly significant difference among the storage period, storage temperature and packaging materials.

Pua *et al.* (2008) [8] found that an increasing trend in terms of moisture uptake in jackfruit powder during storage in aluminum laminated polyethylene and metallized co - extruded biaxially oriented polypropylene pouches at 38 °C. After 12 months of storage, the moisture content was increased from 3.47 per cent to 3.56 per cent in aluminum laminated polyethylene and to 3.65 per cent in metallized co-extruded bi axially oriented polypropylene pouches. Similar increasing trend in the moisture content was observed in the samples stored in both the conditions in the present study too.

Acidity (Table -3)

The changes in the acid content among the muskmelon fruit powder was noted between the storage temperatures, packaging materials and also in different storage period. The acid content was decreased in all the samples in all the packaging materials as the storage period increases. A minimum change in acidity was found in the sample stored in refrigeration temperature (0.100 to 0.090). As the storage period increases, variation in the acid content among the samples packed in different packaging materials was observed. The fruit powder packed in P₃ recorded slightly higher acid content. The freshly prepared muskmelon fruit powder contained 0.100 per cent acidity which decreased to 0.075 in R₁P₁, 0.080 in R₁P₂, 0.084 in R₁P₃, 0.085 in R₂P₁, 0.087 in R₂P₂ and 0.090 in R₂P₃ percent respectively.

Statistical analysis of the data showed a highly significant difference in the acid content among the storage period, storage temperature and packaging materials. Prabha *et al.* (1994) observed a gradual decrease in the acid content of the mixed vegetable soup mixes during storage. They reported that this might be due to interaction between the organic constituents of product and enzyme, which results in the decrease of acidity.

pH

The changes noted in the pH among the samples during storage packed in P₁, P₂ and P₃ stored at R₁ and R₂ was presented in Table -4. As the acid content decreases, the pH of the samples was found to be increased. The changes in the acidity had influenced the pH of the samples during their storage in different packaging materials as well as in the storage conditions. The pH of the freshly prepared fruit powder was 5.39. At the end of 180 days, the pH ranged between 6.49 and 7.18 and 5.99 and 6.41 in room and refrigeration temperatures respectively. Among the samples, the sample stored in refrigeration temperature recorded slightly lower pH than the room temperature during storage. Similar to acid content, the pH value of samples packed in P₁ exhibited maximum changes in pH stored at room and refrigeration temperatures.

A significant difference in the pH of the muskmelon fruit powder was observed between the storage period, storage conditions and packaging materials.

Shreshtha (1982) [12] reported that the pH of the cream based spray dried tomato soup mix samples ranged between 5.10 and 5.22. They also stated that pH of the soup mixes increased from 5.14 to 5.23 after stored for three months at 30 ± 10 °C. In this present investigation, the similar trend was observed.

Total soluble solids (TSS)

The TSS of the stored samples did not show any significant changes during the storage period neither in the storage temperatures nor in the packaging materials. The TSS values noted at zero days was 55 °brix and at the end of storage period 55.4, 55.2 and 55 °brix in P₁R₁, P₂R₁ and P₃R₁ and 55.1, 55.1 and 55 °brix in P₁R₂, P₂R₂ and P₃R₂ respectively.

Saravanan (2008) [10] reported that during storage of spiced dehydrated shreds of raw mango and aonla at room temperature, TSS remained unchanged. Kadam *et al.* (2010) [6] reported that TSS of foam mat dried mango powder contained 8 - 7.9 °brix. Similar picture was observed in the present study among the samples selected for the study.

Total sugar

The changes noted in the total sugar content of the spray dried muskmelon fruit powder are given in the Table - 5. As the

storage period increases, the total sugar content showed a decreasing trend in all the samples stored in P₁, P₂ and P₃ of R₁ and R₂. The sample stored in room temperature recorded higher reduction of total sugar content after 180 days of storage. Whereas the samples stored in refrigerated temperature showed a remarkable retention in their total sugar content in (P₁, P₂ and P₃) when compared to the same samples stored at room temperature. In both the storage conditions, the sample stored in P₃ seems to have better retention of total sugar content than in P₁ and P₂. The freshly prepared samples contained 25.07 per cent of total sugar. After storing for 180 days in P₁, P₂ and P₃ the samples stored in R₁ and R₂ retained 17.50, 19.21 and 21.24 and 20.62, 21.69 and 22.24 per cent of total sugar respectively. The reduction in the total sugar might be due to the conversion of total sugar into simple sugars in the samples during the storage period.

A significant difference was observed among the prime factors like D, P, T and the combined interaction of factor such as DP, PT, TD and DPT in spray dried muskmelon fruit powder.

Shunmugapriya and Vennila (2018) [11] found that the total sugar content of drumstick soup mix decreased from 15.86 to 14.60 per cent during storage for six months. Similar reduction in total sugar content was noted in the present study in all the samples stored in room and refrigeration conditions.

Reducing sugar

The conversion of total sugar (Table - 6) into simple sugar might have increased the reducing sugar content of stored spray dried muskmelon fruit powder. The storage periods, packaging materials and storage conditions had exhibited their influence on the reducing sugar content of the stored samples between 0 and 180 days. A highly significant increase in the reducing content of fruit powder was attained in the samples stored at room temperature than in refrigeration temperature. The initial reducing sugar content was 11.82 per cent. The corresponding final values of reducing sugar in R₁ were 15.69 (P₁), 14.32 (P₂) and 13.19 (P₃) per cent and in R₂ 14.10 (P₁), 13.25 (P₂) and 12.78 (P₃) per cent. Among the packaging materials, the fruit powder stored in MPP (P₃) showed lesser increase in reducing sugar than in aluminum foil (P₂) and poly propylene (P₁) in both the storage conditions during the study period.

A statistical analysis of the data indicated that there existed a significant difference in the reducing sugar content among the storage period, storage conditions and packaging materials.

Kalsi and Dhawan (2001) [7] revealed that a significant increase in the reducing sugar content was observed during two months storage of osmo - dried guava powder. The changes in the reducing sugar content during storage may be attributed to inversion of non reducing sugars by acid hydrolysis of sucrose. In the present study similar increasing trend had been noticed in the spray dried muskmelon fruit powder at the end of the storage.

β - Carotene

The changes observed in the β - carotene content of muskmelon fruit powder is presented in Table - 7. The reduction in β - carotene was highly influenced by the storage conditions, packaging materials and storage period. The β - carotene content of the samples stored in refrigeration temperature showed minimum reduction (7.09 to 10.00%) than the samples stored in room temperature (7.88 to 17.24%). In both the storage conditions the per cent retention in β - carotene found to be high in the samples packed in P₃ at

the end of storage. The freshly prepared fruit powder had recorded 988.9 $\mu\text{g}/100\text{ g}$ of β - carotene. The corresponding values packed in P_1 , P_2 and P_3 of R_1 and R_2 after 180 days were 818.35, 874.20 and 911.5 and 890.1, 904.2 and 919.3 $\mu\text{g}/100\text{ g}$ respectively.

A significant difference in β - carotene was noted among prime factors like D, P, T and the combined interaction of factor such as DP, PT, TD and DPT in spray dried muskmelon fruit powder.

Hymavathi (2002) investigated the retention of total and β - carotene in four mango powders packed in (PP) polyester poly (40.2 μm) and metallised polyester poly (12 μm) / polyethylene (40.2 μm). The per cent loss of total carotene was significantly lower (43.6%) in the MPP packed powder than that of PP packed powders (61.7%) which was obviously due to packaging materials permeability for the oxygen and light. Retention of total carotene ranged from 52 to 57 and 34 to 49 per cent upto six months in MPP and PP packed powder respectively. The results obtained for β - carotene in the present study are in agreement with above literature cited.

Ascorbic acid

The changes noticed in the ascorbic acid content of spray dried muskmelon fruit powder during the study period is presented in Table -8. The storage conditions, packaging materials and storage period had greatly influenced the ascorbic acid content of the samples at the end of 180 days of storage. The retention of ascorbic acid content in all the samples packed in P_1 , P_2 and P_3 stored at R_2 was maximum (84.99 to 78.4%). The highest percentage loss of ascorbic acid was observed in all the samples stored at room temperature packed in P_1 , P_2 and P_3 (17.92 to 27.44 per cent). The samples stored in MPP (P_3) had recorded lesser percentage loss of ascorbic acid than the rest of the packaging materials in both the storage conditions. Initially, the ascorbic acid content of fruit powder was 97.63 mg/100g, whereas at the end of the storage the values noted were 70.84 (P_1), 75.44 (P_2) and 80.13 (P_3) and 76.54 (P_1), 79.05 (P_2) and 82.98 (P_3) mg of ascorbic acid per 100 g respectively.

The statistical analysis of the data revealed that a significant decrease in ascorbic acid content throughout the storage period between the storage period, storage condition and packaging materials in spray dried muskmelon fruit powder.

Saravanan (2008) ^[10] reported that the highest quantity of ascorbic acid loss (25 - 40%) was noted in the spiced dehydrated amla and raw mango shreds throughout the storage period of 180 days at room temperature. The result of the present study was found to be similar to the earlier studies.

Total antioxidant activity (Table - 9)

A remarkable change in the total antioxidant activity of spray dried muskmelon fruit powder was observed during storage period (180 days). The freshly prepared fruit powder contained 14.34 mg/g of total antioxidant activity. Among the packaging materials, MPP had higher total antioxidant activity followed by P_2 and P_1 at the end of 180 days in both the storage conditions. A notable reduction in the total antioxidant activity was noticed during storage in all the samples packed in P_1 , P_2 and P_3 of R_1 and R_2 . At the end of storage, the percentage loss of total antioxidant activity ranged from 14.29 to 27.61 in R_1 and 9.48 to 19.45 in R_2 .

The statistical analysis showed that a significant reduction in the total antioxidant activity of the spray dried muskmelon fruit powder was seen between storage temperatures, storage period and packaging materials.

Vennila and John Kennedy (2013) ^[15] reported that the spray dried beetroot powder contained initially 16.36 mg/g of total antioxidant activity. After 180 days of storage, the total antioxidant activity slightly decreased to 13.15 - 14.05 in R_1 (room temperate) and 14.18 - 14.76 mg/g in R_2 (refrigeration temperature) respectively packed in aluminium pouches (P_1), brown PET bottles (P_2) and brown glass bottles (P_3). Similar trend of change in antioxidant activity was observed in the present investigation too.

Colour values

The changes in the colour values of the spray dried muskmelon fruit powder during storage are given in Table - 10. The colour values L^*a^* and b^* exhibited a gradual reduction during storage in all the fruit powders packed in P_1 , P_2 and P_3 and stored at R_1 and R_2 . The fruit powder stored in MPP had minimum change in colour values than aluminium foil and polypropylene stored at room and refrigeration temperatures. The initial colour values $L^*a^*b^*$ were 95.92, 4.17 and 22.12 in room and refrigeration temperatures respectively. At the end of storage (180 days) the colour values of P_3 showed greater retention of $L^*a^*b^*$ (94.00, 3.85 and 21.67) followed by P_2 and P_1 and stored at refrigeration temperature (R_2). In the refrigeration temperature, the fruit powder packed in P_1 , P_2 and P_3 showed a slight reduction in their $L^*a^*b^*$ values at the end of 180 days. The final colour values were 90.85, 2.82 and 20.79 in R_1P_1 , 92.21, 3.24 and 21.18 in R_1P_2 and 92.53, 3.65 and 21.39 in R_1P_3 and 92.87, 3.18 and 21.06 in R_2P_1 , 93.51, 3.49 and 21.38 R_2P_2 and 94.00, 3.85 and 21.67 R_2P_3 .

Kadam *et al.* (2010) ^[6] analyzed the colour values of foam mat dried tomato powder at different drying temperature (60 - 70 °C) and also different concentrations of egg albumin (5 - 20%). The colour values ranged from L - 48.49 ± 1.11 - 55.48 ± 0.48 , a - 19.46 ± 0.34 - 26.45 ± 0.84 and b - 16.14 ± 0.16 - 20.34 ± 0.54 . Similar picture was noticed in the present study too.

Microbial changes of muskmelon fruit powder

The data pertaining to the changes in the microbial load of the spray dried muskmelon fruit powder during storage are presented in Table - 11. The microbial population was analyzed before and after storage of the samples selected for the study (0 and 180 days). As the storage period progresses a slight increase in the microbial population was noted among the samples. The packaging materials and the storage conditions exhibited their influence on the microbial population of the samples during the study period. In general the microbial population of the samples packed in P_3 and stored in R_1 and R_2 showed only a minimum count whereas in R_2 , packed in P_2 and P_3 had negligible count at the end of the storage period. Initially the bacterial population of fruit powder was 2×10^6 cfu g⁻¹ which had changed to $4 - 7 \times 10^6$ cfu g⁻¹ and $2 - 3 \times 10^6$ cfu g⁻¹ respectively stored in R_1 and R_2 and packed in P_1 , P_2 and P_3 .

Initially the fungal population was not observed in muskmelon fruit powder. At the end of 180 days of storage the population $3 - 4 \times 10^4$ cfu g⁻¹ was developed in room temperature and 1×10^4 cfu g⁻¹ in refrigeration temperature. Similar to fungal population, initially there was nil in yeast population in the muskmelon fruit powder. But at the end of 180 days of storage, the population $2 - 3 \times 10^4$ was developed in R_1 and 1.0×10^4 cfu g⁻¹ in refrigeration temperature. In general the microbial population of the muskmelon fruit powder showed only a minimum count at the end of storage

period. This may be due to careful selection of raw materials and proper method of processing and preservation of fruit powder.

Saravanan (2008) ^[10] reported that the microbial load of spiced dehydrated shreds from mango and amla was well within the permissible limits. Similar results have also reported by Shunmugapriya and Vennila (2018) ^[11] in the soup mix from drumstick during storage. The results of the present study was found to be similar to the earlier studies.

Organoleptic characteristics of muskmelon fruit powder

The muskmelon fruit powder was organoleptically evaluated every month by using a panel of ten untrained judges with 9 to 1 hedonic scale. The sensory attributes viz., colour and appearance, texture, flavour, taste and overall acceptability of the fruit powder showed slight variation between themselves packed in P₁, P₂ and P₃ and stored at R₁ and R₂. The average score values of spray dried muskmelon fruit powder was taken for discussion in this section (Table - 12). The change in the quality attributes directly influenced in the organoleptic evaluation scores. As the storage period progress there was a slight change in the colour and appearance, texture, flavour, taste and overall acceptability of the product.

From the study it was observed that the fruit powder stored at refrigeration temperature scored higher score values in all the quality attributes such as colour and appearance, texture, flavour, taste and overall acceptability than the fruit powder stored at room temperature. The quality attributes of the fruit powder packed in MPP showed very slight difference during the storage period stored at R₁ and R₂.

The maximum score values were noted in P₃ followed by P₂ and P₁ throughout the storage period in all the quality attributes stored at R₁ and R₂. The quality attributes of the muskmelon fruit powder were graded as like extremely to dislike very much with score value as 9 - 1. Initially the colour and appearance score values of R₁ and R₂ was 8.9 and after that it gradually reduced during storage. The fruit powder was awarded as like very much between 0 and 180 days stored at P₃R₁ whereas P₁R₁, P₂R₁, P₁R₂, P₂R₂ and P₃R₂ scored like moderately (8.2 - 8.7).

Among the fruit powder, the fruit powder recorded the maximum score value of R₁ and R₂ was 8.9 for texture initially and at the end of storage period which slightly reduced to 8.4 in R₁P₁, 8.5 in R₁P₂, 8.6 in R₁P₃, 8.5 in R₂P₁, 8.6 in R₂P₂ and 8.7 in R₂P₃.

The muskmelon fruit powder stored at refrigeration temperature showed the maximum score values for flavour throughout the storage period packed in MPP. Initial score values of flavour was 8.9 in R₁ and R₂ and the corresponding values at the end of 180 days were 8.1 in P₁R₁, 8.2 in P₂R₁, 8.4 in P₃R₁ and 8.2 in P₁R₂, 8.3 in P₂R₂ and 8.5 in P₃R₂. Similarly at zero days the taste scores was 8.8 in R₁ and R₂ and at the end of 180 days the values were 8.1, 8.3, 8.4 and 8.2, 8.5 and 8.6 in R₁P₁, R₁P₂, R₁P₃, R₂P₁, R₂P₂ and R₂P₃ respectively.

As the storage period advanced there was a continuous slight reduction in the overall acceptability scores irrespective of storage temperatures and packaging materials. However the decrease was higher at room temperature than at refrigeration temperature. This might be due to the retardation of chemical reactions at refrigerated temperature. The initial overall acceptability score values of R₁ and R₂ was 8.9. The overall acceptability score values of all the samples ranged between 8.9 and 8.2 in P₁R₁, 8.9 and 8.3 in P₂R₁, 8.9 and 8.4 in P₃R₁, 8.9 and 8.4 in P₁R₂, 8.9 and 8.5 in P₂R₂ and 8.9 and 8.6 in P₃R₂.

The organoleptic characteristics of the dehydrated aonla slices was studied by Gajanana *et al.* (2006). Significantly higher scores for colour and appearance (3.88), texture (3.38), taste (3.50) and overall acceptability (3.50) were recorded in the dried samples T₁ (blanched for 2.0 minutes and steeped in 50 °brix syrup for 24 hrs) and dried at 60 °C for 15 hrs. In the present study similar picture was observed among the spray dried muskmelon fruit powder initially and slightly reduced their scores during the study period.

Table 1: Physico - chemical characteristics of spray dried muskmelon fruit powder

Characteristics		Values
Moisture (%)		4.19
TSS (°brix)		55.00
Acidity (%)		0.10
Ph		5.39
Total sugar (%)		25.07
Reducing sugar (%)		11.82
β-carotene (µg /100g)		988.99
Ascorbic acid (mg/100g)		97.63
Color values	L*	95.92
	a *	4.17
	b *	22.12

Table 2: Changes in the moisture content (%) of spray dried muskmelon fruit powder during storage

Storage period (days)	Muskmelon fruit powder					
	Room temperature (R ₁)			Refrigeration temperature (R ₂)		
	P ₁	P ₂	P ₃	P ₁	P ₂	P ₃
0	4.19	4.19	4.19	4.19	4.19	4.19
30	4.27	4.22	4.21	4.23	4.21	4.20
60	4.33	4.27	4.25	4.27	4.26	4.24
90	4.41	4.32	4.29	4.32	4.30	4.27
120	4.50	4.41	4.35	4.39	4.37	4.31
150	4.69	4.55	4.41	4.47	4.44	4.35
180	4.87	4.69	4.47	4.56	4.52	4.39
Source	SED		CD (0.05)	CD(0.01)		
D	0.04209		0.08370	0.11093**		
P	0.02250		0.04474	0.05930**		
T	0.02755		0.05479	0.07262**		
DP	0.05952		0.11837	0.15688**		
PT	0.03897		0.07749	0.10270**		
TD	0.07290		0.14497	0.19214**		
DPT	0.10309		0.20502	0.27173**		

P₁- Polypropylene (PP), P₂- Aluminum foil (AF), P₃-Metallised Polypropylene (MPP)

Table 3: Changes in the acidity (%) of spray dried muskmelon fruit powder during storage (DWB)

Storage period (days)	Muskmelon fruit powder					
	Room temperature (R ₁)			Refrigeration temperature (R ₂)		
	P ₁	P ₂	P ₃	P ₁	P ₂	P ₃
0	0.100	0.100	0.100	0.100	0.100	0.100
30	0.094	0.098	0.098	0.098	0.098	0.099
60	0.089	0.094	0.096	0.096	0.097	0.098
90	0.087	0.091	0.095	0.092	0.095	0.096
120	0.082	0.088	0.091	0.089	0.092	0.094
150	0.079	0.085	0.088	0.087	0.089	0.092
180	0.075	0.080	0.084	0.085	0.087	0.090

P₁. Polypropylene (PP), P₂. Aluminum foil (AF), P₃.Metallised Polypropylene (MPP)

Source	SED	CD (0.05)	CD(0.01)
D	0.00099	0.00197	0.00262**
P	0.00053	0.00106	0.00140**
T	0.00065	0.00129	0.00171**
DP	0.00140	0.00279	0.00370**
PT	0.00092	0.00183	0.00242**
TD	0.00172	0.00342	0.00453**
DPT	0.00243	0.00484	0.00641**

Table 4: Changes in the pH of spray dried muskmelon fruit powder during storage

Storage period (days)	Muskmelon fruit powder					
	Room temperature (R ₁)			Refrigeration temperature (R ₂)		
	P ₁	P ₂	P ₃	P ₁	P ₂	P ₃
0	5.39	5.39	5.39	5.39	5.39	5.39
30	5.50	5.48	5.49	5.46	5.45	5.44
60	5.56	5.53	5.60	5.59	5.61	5.50
90	5.89	5.70	5.74	5.70	5.86	5.62
120	6.22	5.94	5.99	5.93	5.97	5.79
150	6.78	6.29	6.21	6.22	6.09	5.87
180	7.18	6.85	6.49	6.41	6.20	5.99

P₁- Polypropylene (PP), P₂- Aluminum foil(AF), P₃-Metallised Polypropylene (MPP)

Source	SED	CD (0.05)	CD(0.01)
D	0.03965	0.07884	0.10450**
P	0.02119	0.04214	0.05586**
T	0.02596	0.05162	0.06841**
DP	0.05607	0.11150	0.14779**
PT	0.03671	0.07300	0.09675**
TD	0.06867	0.13656	0.18100**
DPT	0.09712	0.19313	0.25598**

Table 5: Changes in the total sugar content (%) of spray dried muskmelon fruit powder during storage (DWB)

Storage period (days)	Muskmelon fruit powder					
	Room temperature (R ₁)			Refrigeration temperature (R ₂)		
	P ₁	P ₂	P ₃	P ₁	P ₂	P ₃
0	25.07	25.07	25.07	25.07	25.07	25.07
30	23.00	24.67	24.86	24.76	24.55	25.00
60	22.18	23.65	24.25	23.89	23.06	24.79
90	21.66	22.94	23.93	22.74	23.71	24.47
120	20.75	21.87	22.06	21.35	22.18	23.98
150	19.89	20.12	22.87	21.98	22.86	23.45
180	17.50	19.21	21.24	20.62	21.69	22.24

P₁- Polypropylene (PP), P₂- Aluminum foil(AF), P₃-Metallised Polypropylene (MPP)

Source	SED	CD (0.05)	CD(0.01)
D	0.20779	0.41322	0.54768**
P	0.11107	0.22087	0.29275**
T	0.13603	0.27051	0.35854**
DP	0.29386	0.58438	0.77454**
PT	0.19238	0.38256	0.50706**
TD	0.35991	0.71571	0.94862**
DPT	0.50898	1.01217	1.34155**

Table 6: Changes in the reducing sugar content (%) of spray dried muskmelon fruit powder during storage (DWB)

Storage period (days)	Muskmelon fruit powder					
	Room temperature (R ₁)			Refrigeration temperature (R ₂)		
	P ₁	P ₂	P ₃	P ₁	P ₂	P ₃
0	11.82	11.98	11.82	11.82	11.82	11.82
30	12.12	11.98	11.95	12.07	11.96	11.89
60	12.86	12.32	12.12	12.29	12.13	11.96
90	13.07	12.81	12.29	12.58	12.34	12.04
120	13.69	13.02	12.33	12.95	12.65	12.26
150	14.34	13.57	12.46	13.23	12.94	12.45
180	15.69	14.32	13.19	14.10	13.25	12.78

P₁- Polypropylene (PP), P₂- Aluminum foil(AF), P₃-Metallised Polypropylene (MPP)

Source	SED	CD (0.05)	CD(0.01)
D	0.11694	0.23255	0.30823**
P	0.06251	0.12430	0.16475**
T	0.07656	0.15224	0.20178**
DP	0.16538	0.32888	0.43590**
PT	0.10827	0.21530	0.28536**
TD	0.20255	0.40279	0.53386**
DPT	0.28645	0.56963	0.75500**

Table 7: Changes in the β - carotene content ($\mu\text{g}/100\text{g}$) of spray dried muskmelon fruit powder during storage (DWB)

Storage period (days)	Muskmelon fruit powder					
	Room temperature (R ₁)			Refrigeration temperature (R ₂)		
	P ₁	P ₂	P ₃	P ₁	P ₂	P ₃
0	988.9	988.9	988.9	988.9	988.9	988.9
30	966.7	979.2	979.6	965.5	976.4	980.1
60	931.4	947.5	963.4	950.8	966.2	972.9
90	901.6	938.6	944.8	947.6	948.7	965.1
120	883.5	921.7	936.1	926.4	931.8	946.3
150	860.9	909.1	920.6	904.7	927.4	930.2
180	818.35	874.20	911.5	890.1	904.2	919.3

P₁- Polypropylene (PP), P₂- Aluminum foil (AF), P₃-Metallised Polypropylene (MPP)

Source	SED	CD (0.05)	CD(0.01)
D	8.10751	16.12273	21.36931**
P	4.33365	8.61796	11.42237**
T	5.30761	10.55481	13.98949**
DP	11.46575	22.80099	30.22076**
PT	7.50610	14.92675	19.78413**
TD	14.04262	27.92539	37.01272**
DPT	19.85926	39.49247	52.34390**

Table 8: Changes in the ascorbic acid content (mg/100g) of spray dried muskmelon fruit powder during storage (DWB)

Storage period (days)	Muskmelon fruit powder					
	Room temperature (R ₁)			Refrigeration temperature (R ₂)		
	P ₁	P ₂	P ₃	P ₁	P ₂	P ₃
0	97.63	97.63	97.63	97.63	97.63	97.63
30	94.02	94.96	95.84	95.82	96.94	97.07
60	88.61	91.94	94.51	93.77	95.61	96.75
90	85.32	87.65	92.80	90.99	93.90	94.18
120	80.98	82.32	88.08	86.68	89.63	92.23
150	75.28	78.00	84.30	85.11	86.74	90.87
180	70.84	75.44	80.13	76.54	79.05	82.98

P₁- Polypropylene (PP), P₂- Aluminum foil (AF), P₃-Metallised Polypropylene (MPP)

Source	SED	CD (0.05)	CD(0.01)
D	0.75453	1.50048	1.98876**

P	0.40332	0.80204	1.06304**
T	0.49396	0.98229	1.30195**
DP	1.06707	2.12200	2.81253**
PT	0.69856	1.38917	1.84123**
TD	1.30689	2.59891	3.44463**
DPT	1.84822	3.67541	4.87144**

Table 9: Changes in total antioxidant activity ($\mu\text{g/g}$) of spray dried muskmelon fruit powder during storage (DWB)

Storage period (days)	Muskmelon fruit powder					
	Room temperature (R_1)			Refrigeration temperature (R_2)		
	P ₁	P ₂	P ₃	P ₁	P ₂	P ₃
0	14.34	14.34	14.34	14.34	14.34	14.34
30	14.00	14.17	14.21	14.19	14.22	14.28
60	13.76	14.01	14.15	14.07	14.14	14.17
90	13.31	13.73	13.96	13.78	13.95	14.03
120	12.86	13.22	13.70	13.24	13.69	13.82
150	11.94	12.54	13.46	12.69	13.12	13.54
180	10.38	11.07	12.29	11.55	12.37	12.98

P₁- Polypropylene (PP), P₂- Aluminum foil(AF), P₃- Metallised Polypropylene (MPP)

Source	SED	CD (0.05)	CD(0.01)
D	0.11591	0.23049	0.30550**
P	0.06195	0.12320	0.16330**
T	0.07588	0.15089	0.20000**
DP	0.16392	0.32597	0.43204**
PT	0.10731	0.21339	0.28284**
TD	0.20076	0.39923	0.52914**
DPT	0.28391	0.56459	0.74832**

Table 10: Changes in the color values of spray dried muskmelon fruit powder during storage (DWB)

Storage period(days)		Musk melon fruit powder					
		Room temperature (R_1)			Room temperature (R_1)		
		P ₁	P ₂	P ₃	P ₁	P ₂	P ₃
0	L*	95.92	95.92	95.92	95.92	95.92	95.92
	a*	4.17	4.17	4.17	4.17	4.17	4.17
	b*	22.12	22.12	22.12	22.12	22.12	22.12
30	L*	95.83	95.86	95.89	95.87	95.89	95.91
	a*	4.12	4.13	4.15	4.14	4.15	4.16
	b*	22.07	22.08	22.10	22.09	22.10	22.11
60	L*	95.81	95.85	95.88	95.85	95.87	95.90
	a*	4.09	4.11	4.13	4.13	4.14	4.15
	b*	22.04	22.06	22.08	22.07	22.09	22.10
90	L*	95.79	95.83	95.87	95.84	95.86	95.89
	a*	4.06	4.09	4.11	4.10	4.12	4.14
	b*	21.97	22.03	22.06	22.05	22.07	22.09
120	L*	92.18	93.13	93.49	94.92	95.25	95.86
	a*	3.59	3.72	3.84	3.91	4.00	4.11
	b*	21.45	21.70	21.97	21.94	21.98	22.02
150	L*	91.17	91.88	92.69	93.01	93.74	94.22
	a*	3.02	3.47	3.85	3.62	3.87	3.96
	b*	21.10	21.39	21.52	21.50	21.69	21.95
180	L*	90.85	92.21	92.53	92.87	93.51	94.00
	a*	2.82	3.24	3.65	3.18	3.49	3.85
	b*	20.79	21.18	21.39	21.06	21.38	21.67

P₁- Polypropylene (PP), P₂- Aluminum foil(AF), P₃-Metallised Polypropylene (MPP)

Particulars	Muskmelon fruit powder					
	Room temperature (R_1)			Refrigeration temperature (R_1)		
	P ₁	P ₂	P ₃	P ₁	P ₂	P ₃
Bacteria cfu ($\times 10^6 \text{ g}^{-1}$)						
Initial	2.0	2.0	2.0	2.0	2.0	2.0
Final	7.0	5.0	4.0	3.0	2.0	2.0
Fungi cfu ($\times 10^4 \text{ g}^{-1}$)						
Initial	0.0	0.0	0.0	0.0	0.0	0.0
Final	4.0	4.0	3.0	3.0	2.0	2.0
Yeast cfu ($\times 10^4 \text{ g}^{-1}$)						
Initial	0.0	0.0	0.0	0.0	0.0	0.0
Final	3.0	3.0	2.0	1.0	1.0	0.0

P₁- Polypropylene (PP), P₂- Aluminum foil (AF), P₃-Metallised Polypropylene (MPP)

Table 12: Changes in the organoleptic characteristics of spray dried muskmelon fruit powder during storage

Quality Attributes	Storage period (days)	Musk melon fruit powder					
		Room temperature (R_1)			Room temperature (R_1)		
		P ₁	P ₂	P ₃	P ₁	P ₂	P ₃
Colour and Appearance	0	8.9	8.9	8.9	8.9	8.9	8.9
	30	8.7	8.8	8.9	8.8	8.9	8.9
	60	8.6	8.7	8.8	8.8	8.9	8.9
	90	8.6	8.6	8.8	8.7	8.8	8.8
	120	8.5	8.5	8.7	8.6	8.7	8.8
	150	8.3	8.4	8.7	8.4	8.6	8.7
Texture	180	8.2	8.3	8.6	8.3	8.5	8.7
	0	8.9	8.9	8.9	8.9	8.9	8.9
	30	8.9	8.9	8.9	8.8	8.9	8.9
	60	8.7	8.8	8.9	8.7	8.8	8.9
	90	8.6	8.7	8.8	8.7	8.8	8.8
	120	8.6	8.6	8.8	8.6	8.7	8.8
Flavour	150	8.5	8.6	8.7	8.6	8.7	8.7
	180	8.4	8.5	8.6	8.5	8.6	8.7
Taste	0	8.9	8.9	8.9	8.9	8.9	8.9
	30	8.7	8.8	8.8	8.8	8.8	8.8
	60	8.6	8.7	8.7	8.7	8.7	8.8
	90	8.5	8.6	8.6	8.6	8.6	8.7
	120	8.4	8.5	8.6	8.4	8.5	8.6
	150	8.2	8.4	8.5	8.3	8.4	8.5
Overall Acceptability	180	8.1	8.2	8.4	8.2	8.3	8.5
	0	8.8	8.8	8.8	8.8	8.8	8.8
	30	8.6	8.7	8.8	8.7	8.8	8.8
	60	8.5	8.6	8.7	8.6	8.7	8.7
	90	8.4	8.5	8.6	8.5	8.6	8.7
	120	8.3	8.4	8.6	8.4	8.6	8.6
Overall Acceptability	150	8.2	8.3	8.5	8.3	8.6	8.6
	180	8.1	8.3	8.4	8.2	8.5	8.6
Overall Acceptability	0	8.9	8.9	8.9	8.9	8.9	8.9
	30	8.7	8.8	8.8	8.7	8.8	8.8
	60	8.6	8.7	8.7	8.6	8.7	8.8
	90	8.5	8.6	8.6	8.6	8.7	8.7
	120	8.4	8.5	8.5	8.5	8.6	8.7
	150	8.3	8.4	8.5	8.5	8.6	8.6
Overall Acceptability	180	8.2	8.3	8.4	8.4	8.5	8.6

P₁- Polypropylene (PP), P₂- Aluminum foil (AF), P₃-Metallised Polypropylene (MPP)

Table 11: Changes in the microbial load (cfu g^{-1}) of spray dried muskmelon fruit powder during storage (DWB)

Conclusion

Muskmelon fruit powder was prepared by using spray drier and its storage stability was studied. The samples stored at refrigerated conditions (4 ± 1 °C) showed negligible chemical, microbial and organoleptic changes during storage period of six months compared to the samples stored at ambient temperature (32 ± 2 °C). Muskmelon fruit powder can be incorporated into the preparation of instant drink, milk shake powder, cakes, cookies, health drink and ice creams.

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