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Effect of packaging and storage on physico-chemical characters of powder prepared by spray drying of blended juices of cashew apple

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Abstract
Cashew (*Anacardium occidentale* L.) belongs to family *Anacardiaceae* is one of the important dry land plantation crop cultivated in India, ranks third in its export value in the international trade for its kernels. The production of cashew apple in India is about 65.36 lakh tones and around 90% of the harvest gets wasted and the remaining 10% of harvested apple is either consumed as fresh or processed industrially. To preserve the juice of this seasonal fruit, spray drying is one of the best method to convert liquid state feed into a dried particulate form and utilized during unseasonal days. The four best treatments of blended juice of cashew apple with other fruit juices were selected and required quantity of powder was prepared from the respective treatments and they were packed in polythene pouches and aluminum pouches and kept for storage as per the treatments. Each pouch was filled with 20 g of powder and sealed immediately with hand sealing machine and kept under ambient condition for storage studies up to 90 days and recorded the physical and chemical parameters at 15 days interval.
The powder with the blended juice treatment combinations of B_1 (75% cashew apple juice + 25% pineapple juice at 170 °C inlet temperature with flow rate of 10 ml/min) has recorded the lowest moisture content (12.30%), the lowest bulk density of 0.369 g/cm^3, lowest wettability of 14.57 seconds and the highest solubility of 92.12% recorded packed in laminated aluminum pouches at initial day of storage and powder quality was retained upto 90th day of storage with free flowing nature. Whereas, in polythene pouches stickiness of the powder was observed from 30th day of storage. The powder packed in laminated pouches can be used for long term storage upto 90 days of storage under ambient condition.

Keywords: Packaging, storage, physico-chemical, powder prepared, apple

Introduction
Cashew (*Anacardium occidentale* L.) belongs to family Anacardiaceae is one of the important dry land plantation crop cultivated in India. The cashew is having commercial value for its cashew nut but its peduncle (false fruit) called cashew apple which is not utilized properly. The production of cashew apple in India is about 65.36 lakh tones (Hubbali, 2019) [4]. Cashew apple juice contains Vitamin C (231.4 mg/100 g), tannins (266.0 mg/100 g) and phenolics (269.5 mg/100 g). In order to reduce astringency, to prevent spoilage and promote its utilization, it is essential to find a suitable method for the preservation of cashew apple juice. The total cashew apple produced in the country, around 90% of the harvest gets wasted (Azevedo and Rodriguez, 2000) [1] and the remaining 10% of harvested apple is either consumed as fresh or processed industrially into a variety of products (Maciel *et al.*, 1986; Nanjundaswamy, 1984) [7, 12]. To preserve this juice in powder form and instant juice powders can meet consumer requirements being cheap to transport and with prolonged shelf life as reported by Cano-Chauca *et al*. (2005).
To achieve this Spray drying is one of the highly appropriate process for heat-sensitive products such as liquid foods and results in powders with good quality, low water activity, easier transport and storage. In the present study the effect of packaging and storage of blended juice powder of cashew apple for their physico-chemical properties were studied for the quality of powders during their storage to preserve for the long time and also for reutilization of the above powders for commercial purpose.

Material and Methods

The present investigation was done at All India Coordinated Research Project on Cashew center at Cashew Research Station, Bapatla, Guntur district, Andhra Pradesh of Dr YSR Horticultural University during the period 2016-18.

The process of blended juice preparation with clarified cashew apple juice with other fruit juices prepared after extraction from mango, orange, pineapple are blended in different ratio of cashew apple juice with other fruit juices. The best blended juice combination which are recorded for different quality parameters of cashew apple juice with other fruit juices lake mango juice, orange juice, pineapple juice respectively and 100% cashew apple juice were taken for making powder at 3 flow rates and 3 temperature levels are studied for the powder recovery and other quality parameters of powder by using spray drying method. The four best treatments based on the powder recovery were selected from the blended juice combinations of cashew apple juice through standardization of inlet temperature and feed flow rate. The four best treatment combinations were taken as detailed below. For evaluation of powder quality in packaging and storage studies, required quantity of powder was prepared from the respective treatments of blended juice, flow rate and temperature where the powder recovered. They were packed in laminated aluminum pouches and polythene pouches. Each pouch was filled with 20 gm of powder and sealed immediately with hand sealing machine and kept under ambient condition for storage studies up to 90 days and recorded the physical and chemical parameters at 15 days interval. The laminated aluminum pouches with a size of 4"x6" having gauge of 300 were used for storage of spray dried blended cashew apple juice powder. The polythene pouches with a size of 4"x6" having gauge of 300 were used for storage. The experiment was designed in factorial CRD with three factors and two replications having 56 treatments.

Factor -1

B_1: 75% Cashew apple juice + 25% Pineapple juice at 170 ºC with flow rate of 10 ml/min

B_2: 75% Cashew apple juice + 25% Pineapple juice at 160 ºC with flow rate of 10 ml/min

B_3: 75% Cashew apple juice + 25% Pineapple juice at 150 ºC with flow rate of 10 ml/min

B_4: 100% Cashew juice at 150 ºC with flow rate of 10 ml/min)

Factor 2: Packaging Spray dried blended juice powder was packed in two types of material *viz*., P_1: Aluminum pouch P_2: Polythene pouch

Factor 3: Storage intervals

The juice powders packed in the pouches were stored in ambient condition and were analyzed for quality parameters at different days of 0, 15th, 30^{th,} 45th, 60th, 75th and 90th day after storage as S_1: 0 day (initial day) S_2:15th day of storage S_3: 30th day of storage S_4: 45th day of storage S_5: 60th day of storage S_6: 75th day of storage S_7: 90th day of storage

Results and Discussion

Moisture content (%)

The moisture in the powder is important factor to preserve the powder for long time and the quality of in blended juice. However results revealed that the lowest moisture content percentage of 12.30% was recorded in B_1 (75% cashew apple juice + 25% pineapple juice at 170 °C inlet temperature with flow rate of 10 ml/min) and the highest (13.99%) was recorded in B_4 (100% cashew apple juice at 150 °C inlet temperature with flow rate of 10 ml/min). Among the different packaging material, the lowest moisture content (12.09%) of the blended cashew apple juice powder was recorded in P_1 (aluminum pouches) over the polythene pouches (P_2) with 14.36%. At different days of storage, the lowest moisture content (9.66%) of the blended cashew apple juice powder was recorded at S_1 (0 day of storage) and highest was recorded in S_7 (90th day of storage) (15.08%).

The moisture content of different blended juice powders as effected by powder obtained at blended juice, flow rate and temperature combination, packaging material and days of storage, the lowest moisture content was recorded in $P_1B_1S_2$ (75% cashew apple juice + 25% pineapple juice at 170 °C inlet temperature with flow rate of 10 ml/min) stored in aluminum pouches at 15th day of storage of 9.95% and the highest was recorded in $P_2B_4S_7$ (100% cashew apple juice at inlet temperature of 150 °C with flow rate of 10 ml/min stored in polythene pouches at 90th day of storage) of 11.11% (Table 2). The increase in moisture content with time was highest in the case of the powder packed in polythene pouches and least in the case of aluminum pouches which may be due to higher water vapour permeability of polythene package than aluminum package. Aruna *et al.* (1998) [2] reported that cereal based papaya powder when stored for nine months, moisture increased According to Singh and Hathan (2017) [14] there was a gradual increase in moisture content of the powder sample in both packages (LAP and HDPE). Malhotra and Mann (1989) [11] reported that ready-to-reconstitute coffee powder could be kept for three months in metalized polyester LDPE laminate at 30±10 ºC in storage.

Bulk density (g/cm^3)

Bulk density is the another important factor to consider the quality of the powder on its storage however results revealed that the blended cashew apple juice powder combination, the lowest bulk density of 0.369 g/cm^3 was recorded in B_1 (75% cashew apple juice + 25% pineapple juice at 170 °C inlet temperature with flow rate of 10 ml/min) and the highest was recorded in B_4 (100% cashew apple juice at 150 °C inlet temperature with flow rate of 10 ml/min) of 0.418 g/cm^3. But with different packaging material, the lowest bulk density of the powder was recorded in P_1 (aluminum pouches) of 0.362 g/cm^3 over the polythene pouches (P_2) of 0.428 g/cm^3. Accordingly, days of storage the lowest bulk density of the blended cashew apple juice powder was recorded at S_1 (0 day of storage) of 0.332 g/cm^3 and highest was recorded in S_7 (90th day of storage) of 0.439 g/cm^3 (Table-1).

The bulk density of different blended juice powders varied from 0.313 to 0.346 g/cm^3 at initial day of storage but the interaction effect of packaging material, blended juice treatment combination and days of storage, the lowest bulk density was recorded in treatment combination of $P_2B_1S_2$ (75% cashew apple juice + 25% pineapple juice at 170 °C inlet temperature with flow rate of 10 ml/min) stored in polythene pouches at 15th day of storage of 0.323 g/cm^3 and the highest was recorded in $P_2B_4S_7$ (100% cashew apple juice at inlet temperature of 150 °C with flow rate of 10 ml/min) stored in polythene pouches at 90th day of storage of 0.534 (Table 2). An increase in the storage period of the powder lead to the absorption of the moisture and in turn increase of the bulk density was observed in powder packed in polythene pouches over the aluminum pouches it might be due to the particles of skin-forming spray dried materials often contain

air bubbles, which can occur as a result of desorption of air that was initially present in the liquid feed or was absorbed during atomization as stated by Kwapinska and Zbicinski (2005) [5]. Generally, an increased volume of trapped air caused a decrease in the apparent density of the particles and this apparent density primarily determined the powder bulk density.

Wettability (sec)

The wettability is also an important factor for its reconstitution from powder stage to its re utilization and keeping quality of the powder. The results revealed in present investigation that, the lowest wettability of 14.57 seconds was recorded in B_1 (75% cashew apple juice + 25% pineapple juice at 170 °C inlet temperature with flow rate of 10 ml/min) and the highest was recorded in B_4 (100% cashew apple juice at 150 °C inlet temperature with flow rate of 10 ml/min) (19.06 seconds). But with different packaging material, the lowest wettability of the powder was recorded in P_1 (aluminum pouches) of 7.91 seconds over the polythene pouches (P_2) (26.61 seconds) at different days of storage the lowest wettability of the powder was recorded at S_1 (0 day of storage) of 6.71 seconds and highest was recorded in S_7 (90th day of storage) of 25.81 seconds (Table-1).The wettability of different blended juice powders varied from 5.20 to 8.15 sec at initial day of storage. But interaction effects of packaging material, blended juice treatment combination and days of storage, the lowest wettability of 5.25 seconds was recorded in treatment combination of $P_1B_1S_2$ (75% cashew apple juice + 25% pineapple juice at 170 °C inlet temperature with flow rate of 10 ml/min) in aluminum pouches at 15th day of storage) and the highest of 48.00 seconds was recorded in $P_2B_4S_7$ (100% cashew apple juice at inlet temperature of 150 °C with flow rate of 10 ml/min) in polythene pouches at 90th day of storage (Table 2). The wettability time of the powder increased with the storage period, as the storage period advances the absorption of moisture content of the powder was increased. The maximum absorption of the moisture by powder was observed in polythene pouches compared to the aluminum pouches. The use of metalized LDPE packs and N_2 flushing assured a shelf life of 4 months for the sapota milk beverage powder under ambient conditions (Maya, 2004) [8]. The shelf life studies of spray dried betalain dye powder for 180 days showed that the dye is quite suitable in the storage temperature range of -4 to 20 °C.

Solubility (%)

The solubility is the important factor in the reutilization of powder into liquid form for ready to serve preparation of blended juices. In the present investigation, the highest solubility of 92.12% was recorded in B_1 (75% cashew apple juice + 25% pineapple juice at 170 °C inlet temperature with flow rate of 10 ml/min) and the lowest (89.56%) was recorded in B_3 (75% cashew apple juice + 25% pineapple juice at 150 °C inlet temperature with flow rate of 10 ml/min). But with the packaging material, the highest of 93.37% solubility of the blended cashew apple juice powder was recorded in P_1 (aluminum pouches) over the polythene pouches (P_2) of 89.04%. In respect to days of storage the highest of 98.36% solubility of the blended cashew apple juice powder was recorded at S_1 (0 day of storage) and the lowest of 84.87% was recorded in S_7 (90th day of storage) (Table-1). The solubility for their interaction effects of packaging material, blended juice treatment combination and days of storage, the highest solubility of 98.28% was recorded in treatment combination of $P_1B_2S_2$ (75% cashew apple juice + 25% pineapple juice at 160 °C inlet temperature with flow rate of 10 ml/min) stored in aluminum pouches at 15th day of storage) followed by $P_1B_4S_2$ (100% cashew apple juice at 150 °C inlet temperature with flow rate of 10 ml/min) stored in aluminum pouches at 15th day of storage) of 98.26% but the lowest of 78.56% was recorded in $P_2B_3S_7$ (75% cashew apple juice + 25% pineapple juice at inlet temperature of 150°C with flow rate of 10 ml/min stored in polythene pouches at 90th day of storage) (Table -2). The solubility of the powder was decreased with the advancement of storage period due to hygroscopic nature of the powder whereas powders stored in polythene pouches adsorbed the moisture during storage period due to the lower capacity of protection of the package thus it became a hard and agglomerated powder in turn decreased the solubility. The cashew apple juice in powder stored in vacuum-sealed laminated package showed higher stability in the storage of 60 days, for better preserving physico-chemical properties in comparison to the vacuum-sealed plastic package (Sanyelle *et al*. 2016) [13].

Colour (L*, a* and b* Values)

The colour of the powder which also provides the indication for the combination of juices and their stability in colour retention and the changes occurs when reconstitution was made in the production of RTS beverages. In the present investigation, the highest colour L***** value of 85.88 was recorded in B_1 (75% cashew apple juice + 25% pineapple juice at 170 ºC inlet temperature with flow rate of 10ml/min) and the lowest of 80.57 was recorded in B_4 (100% cashew apple juice at 150 °C inlet temperature with flow rate of 10ml/min). The colour b* value was recorded highest of 14.77 in B_2 (75% cashew apple juice + 25% pineapple juice at 160 °C inlet temperature with flow rate of 10 ml/min) and the lowest of 11.54 was recorded in B_1 (75% cashew apple juice + 25% pineapple juice at 170 °C inlet temperature with flow rate of 10 ml/min). Whereas, the lowest colour a* value of 0.23 was recorded in B_4 (100% cashew apple juice at 150 °C inlet temperature with flow rate of 10 ml/min). With regard to packaging material, the highest colour L***** and b* values of 83.53 and 12.79 were recorded respectively in P_1 (aluminum pouches) and lowest values of 81.17 and 12.73 were recorded in P_2 (polythene pouches), respectively. Whereas the colour a* value was recorded lowest in P_2 (polythene pouches) of 0.54 and the highest was recorded in P_1 (aluminum pouches) of 0.58 but for the days of storage, the highest colour L***** and b* values of 85.56 and 14.04 were recorded in S_1 (0 day of storage) respectively and lowest values were recorded at 90th day of storage of 78.52 and 11.66, respectively (Table-1).

The interaction effect of blended juice treatment combination, packaging material and days of storage, the highest of 90.72 colour L***** value in treatment combination of $B_1P_2S_1$ (75% cashew apple juice + 25% pineapple juice at inlet temperature of 170 °C with flow rate of 10 ml/min) packed in polythene pouches at 0 day of storage followed by $B_1P_1S_1$ (75% cashew apple juice + 25% pineapple juice at inlet temperature of 170 °C with flow rate of 10 ml/min) packed in aluminum pouches at 0 day of storage while the lowest values were recorded in $B_4P_2S_7$ (100% cashew apple juice at inlet temperature of 150 °C with flow rate of 10 ml/min stored in polythene pouches at 90th day of storage) of 71.23. The colour a* value was recorded lowest in $B_4P_1S_1$ (100% cashew apple juice at inlet temperature of 150 °C with flow rate of 10 ml/min) stored in aluminum pouches at 0 day of storage) of 0.14 and the highest was recorded in $B_2P_1S_7$ (75% cashew apple juice + 25%

pineapple juice at inlet temperature of 160 °C with flow rate of 10 ml/min stored in aluminum pouches at 90th day of storage) and $B_2P_2S_7$ (75% cashew apple juice + 25% pineapple juice at inlet temperature of 160 °C with flow rate of 10 ml/min stored in polythene pouches at 90th day of storage) of 1.32. Whereas the colour b* value was recorded highest in $B_2P_2S_1$ (75% cashew apple juice + 25% pineapple juice at inlet temperature of 160 °C with flow rate of 10 ml/min) stored in polythene pouches at 0 day of storage) of 17.30 and the lowest was recorded in $B_1P_1S_6$ (75% cashew apple juice + 25% pineapple juice at inlet temperature of 170 °C with flow rate of 10 ml/min) stored in aluminum pouches at 75th day of storage) of 10.56 (Table 2). The increased rate of darkness in sample at room temperature may be due to the increased rate of oxidation within the sample, causing an increased redness and subsequently darkness of the sample. The reason for the increase in the redness of the sample stored at room temperature is probably due to the increased rate of oxidation at room temperature than to the refrigeration temperature which can be easily correlated with L* value of stored powder (Mishra *et al*. 2014) [10]. Irrespective of the package used L* and a* values increased while b* value decreased during storage of the powder in accelerated environment and more colour change was found in beetroot powder stored in HDPE package Singh and Hathan (2017) [14].

Table 1: Effect of blended juice combinations, packaging material and days of storage on physico-chemical parameters of powder prepared by spray drying method

Treatments	Moisture content %	Bulk Density (g/cm3)	Wettability (Sec)	Solubility (%)	L*	a*	b*
B1	12.30	0.369	14.57	14.57	85.88	0.37	11.54
B2	12.85	0.382	16.76	16.76	84.62	1.25	14.77
B3	13.36	0.410	18.65	18.65	80.57	0.39	12.37
B4	13.99	0.418	19.06	19.06	70.33	0.23	12.36
S.Em±		0.001	0.21	0.21	0.15	0.001	0.023
CD (0.05)		0.003	0.60	0.60	0.42	0.003	0.065
P_1	12.09	0.362	7.91	7.91	83.53	0.58	12.79
P_2	14.36	0.428	26.61	26.61	81.17	0.54	12.73
S.Em±	0.02	0.001	0.15	0.15	0.10	0.001	0.02
CD (0.05)	0.06	0.003	0.42	0.42	0.30	0.002	0.05
S_1	9.66	0.332	6.71	6.71	85.56	0.50	14.04
S_2	12.31	0.348	11.75	11.75	85.09	0.51	13.46
S_3	13.04	0.382	14.83	14.83	83.70	0.53	13.11
S_4	13.57	0.416	15.58	15.58	82.62	0.56	12.71
S_5	13.94	0.419	21.29	21.29	80.92	0.63	12.36
S_6	14.28	0.428	24.84	24.84	80.03	0.61	11.98
S_7	15.08	0.439	25.81	25.81	78.52	0.59	11.66
S.Em±	0.04	0.001	0.28	0.28	0.19	0.001	0.03
CD (0.05)	0.11	0.003	0.79	0.79	0.55	0.004	0.09

Table 2: Interaction effects of blended juice combinations, packaging material and days of storage on physico-chemical parameters of powder prepared by spray drying method

Interactions	Moisture content %	Bulk Density (g/cm3)	Wettability (Sec)	Solubility (%)	L*	a*	b*
$B_1P_1S_1$	8.85	0.313	5.20	98.88	89.67	0.29	12.30
$B_1P_1S_2$	9.95	0.334	5.25	98.22	89.59	0.33	12.14
$B_1P_1S_3$	11.25	0.346	5.40	98.10	88.54	0.32	11.34
$B_1P_1S_4$	11.8	0.358	5.95	94.06	87.25	0.37	11.35
$B_1P_1S_5$	12.2	0.358	7.05	92.01	84.50	0.39	11.24
$B_1P_1S_6$	12.6	0.365	9.00	88.94	83.91	0.42	10.56
$B_1P_1S_7$	12.85	0.370	9.15	87.00	83.60	0.43	10.72
$B_2P_1S_1$	9.95	0.323	6.25	98.38	88.32	1.20	17.20
$B_2P_1S_2$	10.85	0.343	7.15	98.28	88.32	1.17	16.21
$B_2P_1S_3$	11.3	0.356	7.25	97.55	86.63	1.20	16.03
$B_2P_1S_4$	12.25	0.365	7.20	89.55	85.42	1.22	15.14
$B_2P_1S_5$	12.65	0.363	8.15	89.08	84.30	1.23	14.76
$B_2P_1S_6$	13.15	0.371	10.10	88.78	84.35	1.30	13.76
$B_2P_1S_7$	13.45	0.383	10.30	87.44	83.16	1.31	13.01
$B_3P_1S_1$	9.9	0.346	7.25	97.43	83.17	0.43	13.10
$B_3P_1S_2$	11.15	0.346	7.20	94.80	83.07	0.42	12.65
$B_3P_1S_3$	11.95	0.383	7.35	94.60	82.52	0.46	12.48
$B_3P_1S_4$	12.75	0.371	7.40	91.43	82.48	0.51	12.09
$B_3P_1S_5$	13.05	0.378	8.20	89.05	82.65	0.52	11.77
$B_3P_1S_6$	13.25	0.385	10.10	88.15	81.12	0.56	11.55
$B_3P_1S_7$	13.75	0.392	10.25	87.27	76.25	0.28	11.10
$B_4P_1S_1$	9.95	0.346	8.15	98.75	81.63	0.13	13.53
$B_4P_1S_2$	11.65	0.348	8.18	98.26	80.84	0.18	13.33
$B_4P_1S_3$	12.9	0.371	8.21	96.19	80.55	0.18	13.28
$B_4P_1S_4$	12.95	0.373	7.20	95.08	79.52	0.24	12.56

$B_4P_1S_5$	13.7	0.385	8.10	94.18	79.10	0.51	12.18
$B_4P_1S_6$	14	0.388	10.20	94.13	79.09	0.27	11.63
$B_4P_1S_7$	14.5	0.409	10.35	88.92	79.22	0.29	11.16
$B_1P_2S_1$	8.85	0.313	5.20	98.88	90.71	0.30	12.22
$B_1P_2S_2$	12.9	0.323	12.10	96.10	88.68	0.33	12.08
$B_1P_2S_3$	13.4	0.385	16.15	90.50	85.41	0.37	11.76
$B_1P_2S_4$	13.85	0.417	23.00	89.05	84.96	0.37	11.56
$B_1P_2S_5$	14.15	0.422	29.90	86.60	83.15	0.41	11.55
$B_1P_2S_6$	14.7	0.435	34.85	86.10	81.65	0.41	11.40
$B_1P_2S_7$	14.85	0.439	35.80	85.30	80.61	0.43	11.26
$B_2P_2S_1$	9.95	0.323	6.25	98.38	86.67	1.20	17.30
$B_2P_2S_2$	13.45	0.358	16.30	95.00	87.60	1.22	15.50
$B_2P_2S_3$	13.85	0.387	25.20	93.75	86.20	1.23	14.65
$B_2P_2S_4$	14.4	0.437	23.00	89.90	84.18	1.25	14.15
$B_2P_2S_5$	14.5	0.436	36.00	87.60	82.13	1.28	13.17
$B_2P_2S_6$	14.85	0.445	35.90	86.58	79.32	1.30	13.12
$B_2P_2S_7$	15.35	0.459	35.60	82.88	78.10	1.31	12.76
$B_3P_2S_1$	9.9	0.346	7.25	97.43	83.20	0.26	13.25
$B_3P_2S_2$	14.15	0.358	18.25	92.13	82.59	0.29	13.12
$B_3P_2S_3$	14.65	0.417	25.10	87.58	81.23	0.31	12.76
$B_3P_2S_4$	14.75	0.506	23.00	85.60	80.55	0.33	12.53
$B_3P_2S_5$	15.25	0.502	38.10	85.05	76.48	0.35	12.42
$B_3P_2S_6$	15.65	0.512	44.60	84.70	76.61	0.37	12.31
$B_3P_2S_7$	16.95	0.530	47.00	78.56	76.01	0.38	12.07
$B_4P_2S_1$	9.95	0.346	8.15	98.75	81.05	0.14	13.39
$B_4P_2S_2$	14.4	0.386	19.55	91.20	80.05	0.14	12.67
$B_4P_2S_3$	15.00	0.435	24.00	88.60	78.53	0.18	12.52
$B_4P_2S_4$	15.8	0.505	27.90	86.55	76.57	0.20	12.29
$B_4P_2S_5$	16	0.513	34.80	84.70	75.08	0.31	11.77
$B_4P_2S_6$	16.05	0.521	44.0	84.20	74.18	0.23	11.52
$B_4P_2S_7$	18.95	0.534	48.00	81.55	71.23	0.24	11.17
S.Em±	0.11	0.002	0.20	1.12	0.55	0.004	0.09
CD (0.05)	0.31	0.004	0.57	3.37	1.56	0.012	0.24
CV%	1.20	0.548	1.64	1.74	0.97	1.087	0.95

Factor-I

B_1	-	75% Cashew apple juice + 25% Pine apple juice at 170 °C inlet temperature with flow rate of 10 ml/min
B_2	-	75% Cashew apple juice + 25% Pine apple juice at 160 °C inlet temperature with flow rate of 10 ml/min
B_3	-	75% Cashew apple juice + 25% Pine apple juice at 150 °C inlet temperature with flow rate of 10 ml/min
B_4	-	100% Cashew apple juice at 150 °C inlet temperature with flow rate of 10 ml/min

Factor-II

P_1	-	Aluminium pouch
P_2	-	Polythene pouch

Factor-III

S_1	-	0 day
S_2	-	15th day of storage
S_3	-	30th day of storage
S_4	-	45th day of storage
S_5	-	60th day of storage
S_6	-	75th day of storage
S_7	-	90th day of storage

At 15th day of storage

Plate 1: Blended juice powders in Aluminum and Polythene pouches at 0 and 15th day of storage

At 0 day of storage

At 30th day of storage

At 45th day of storage

Plate 2: Blended juice powders in Aluminum and Polythene pouches at 30th and 45th day of storage

At 60th day of storage

At 75th day of storage

Plate 3: Blended juice powders in Aluminum and Polythene pouches at 60th and 75th day of storage

Conclusion

In the present study for evaluation of powder quality in packaging and storage studies, required quantity of powder was prepared from the respective treatments of blended juice, flow rate and temperature where the powder recovered. They were packed in laminated aluminum pouches and polythene pouches and kept under ambient condition for storage studies up to 90 days and recorded the physical and chemical parameters The powder quality was retained up to 90th day of storage in laminated pouches with respect to the less moisture percentage, lowest wettability time, highest solubility % and retention of colour and physically powder is having free flowing nature in the 75% cashew apple juice + 25% pineapple blended juice powder obtained at 170 °C inlet temperature with flow rate of 10 ml/min by spray drying method when compared to polythene pouches. Hence, it is having utility industrially for storage with quality for the preparation of ready to serve beverage by using blended cashew apple juice powder packed in laminated aluminum pouches.

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