Int.J.Curr.Microbiol.App.Sci (2020) *9*(5): 593-611

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 9 Number 5 (2020)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2020.905.067

Composition and Characterization of Foam Mat Dried Powder Prepared From Seedling and Cultivated Mango Cultivars of Himalayan Region

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A B S T R A C T

Keywords

Mango cultivars, Seedling mango, CMC, Foam mat drying, Mango powder, Physico - chemical properties

Article Info

Accepted:
05 April 2020
Available Online:
10 May 2020

Three cutivars of mango viz; *Amrapali*, *Dashehari*, *Mallika* and one seedling mango were evaluated for production of foam mat dried powder. Initially, physico-chemical properties were determined. Mango Pulp of different cultivars was foamed by carboxy -methyl - cellulose (CMC) at different concentrations 0, 1.0 and 2.0% followed by drying in tray drier for preparation of instant mango powder. Out of different concentrations, use of 2% carboxy methyl cellulose in each variety was found the most appropriate for foaming of mango pulp on the basis of foaming properties (foam density, foam expansion and foam stability), physico-chemical and sensory attributes . Among different cutivars, the yield of dried powder varied from 13.72 -15.10 %. By using different concentrations of foaming agent, Dried mango powders contained 80.50-83.70 °B TSS, 0.94-1.53 % titratable acidity, 4.00-4.79 pH, 5.50-6.19 % moisture content, 4.50-4.65 % ash content, 40.95-48.62 % reducing sugars, 73.99-80.05 % total sugars and 11.77 to 12.49 mg/100g total carotenoids.

Introduction

Mango (*Mangifera indica* L.), also called as king of fruits, is the second important fruit crop of India after banana with an annual production of 21822.32 thousand metric tonnes from an area of 2258.13 thousand hectare (NHB, 2018). The major Mango producing states in India are Uttar Pradesh, Andhra Pradesh, Bihar, Karnataka and Tamil Nadu. Mango is one of the important indigenous fruit of our country belonging to the family Anacardiaceae and is known for its wide adaptability, high nutritive value, delicious taste, excellent flavor, attractive appearance and popularity among users

(Barreto *et al.,* 2008; Negi, 2000). In Himachal Pradesh, mango cultivation covered an area of 0.423 million hectare with an annual production of 0.436 million metric tonnes during the year 2018-19accounts for 8.80 and 18.23 % of total production and area under fruit crops, respectively .Mangoes fruits are considered to have a good texture, flavor and high content of carotenoids, Vitamin C, phenolic compounds, minerals and fiber. Its consumption can provide antioxidants and is continuous intake in diet helps to prevent cardiovascular diseases and cancer (Danalache *et al.*, 2015). Wide gap between total production and consumption, due to high perishability and susceptibility to mechanical damage during post harvest handling, poor transportation and storage facilities leads to post harvest losses (Mitra and Baldwin 1997). Jha *et al.,* (2015) reported 6.92% losses during farm operations (harvesting, sorting, grading, and transportation) and 2.24% losses during storage channel in mango fruits.

Processing of fruit minimizes these losses to some extent and gives better returns to the farmers during glut seasons. Therefore, the conversion of ripe mango into processed products could be useful not only to reduce the post harvest losses but also retain nutritional quality in the processed products. Freshly harvested, ripe fruits which remain in good condition only for few days can be converted to commercial food commodities like pulp, juices, jam, nectars, etc by using various methods of processing (Ladole *et al.*, 2014; Jori *et al*., 2013).

Among different techniques of processing, drying is the major food processing operation to increase the shelf life. The purpose of drying of fruit and vegetable juices is to produce a stable and easily handled form of the juice, which reconstitutes rapidly to a quality product resembling the original juice as closely as possible. The foam mat drying is one of the methods of dehydrating liquid foods in a very short period. Due to the porous structure of the foamed materials, mass transfer is enhanced leading to shorter dehydration times. This technique can be successfully employed for drying a variety of fruit juices and pulps. The dried powders have good reconstitution characteristics (Sharada, 2013). In foam mat drying process, dehydration is rapid, the colour and flavor are superior because of minimum heat-damage, the product is a free- flowing powder capable of instant rehydration in cold water and the process is achieved with a minimum cost (Rockwell *et al.*, 1962).

The basic principle involved in the foam mat drying consists of conversion of liquid or semisolid material into stable foam by incorporating substantial volume of air or other non-toxic gases in the presence of a certain additives which works as foam inducer and stabilizer. The foam thus formed is spread on a mat in a thin layer and is exposed to a steam of hot air until it is dehydrated. The dehydrated product is conditioned and converted into powder (Srinivasan, 1996).

Besides cultivated varieties, the availability of Seedling mango fruits especially in low-hills of Himachal Pradesh is very high but, large quantity of such fruits goes waste during harvesting season. Therefore, development of product like instant mango powder can be an alternative for efficient utilization of Seedling mango as well as other varieties available in the area.

Materials and Methods

Fruits of three cultivars of mango viz. *Amrapali*, *Dashehari* and *Mallika* collected from Regional Horticulture and Forestory Research & Training Centre Bhota and seedling mango from surrounding areas of the

District Hamirpur in Himachal Pradesh were used for pulp extraction .Fully ripe and firm mango fruits after washing and peeling were cut into halves and passed through the pulper for extraction of pulp. The pulp was heated at 90^{o}C.and preserved with potassium meta-bisulphite (2g/kg of pulp) in sterilized glass bottles for its later utilization for product development and analytical purposes.The pulp being thin and juicy was converted into stable foam by whipping the pulp in a blender for 5 min after addition of CMC @ 0–2% followed by spreading the foam on stainless steel trays (30 × 20 cm^2, with a tray load of 150 g per tray) in a thin layer (3–5 mm) and dried in a mechanical dehydrator (60 ± 5 °C) for about 4- 8 h. to a moisture content . The dried foam was scrapped from the trays and ground to a fine powder followed by packing in aluminum pouches and stored for further experimentation. The complete process for preparation of mango powder is given in figure 1.

Physical properties

Fruit sizewas determined by using Vernier Caliper. Weight in grams was determined gravimetrically and expressed as mean weight (g). Pulp, peel and stone percentage were calculated based on the method adopted by Badhe *et al*., (2007).

Chemical analysis

The total soluble solids (°B), titratable acidity, moisture content (%), ascorbic acid (mg/100gm), total carotenoids (mg/100 mg), and ash content (%) of papaya pulp and prepared powder were determined using standard analytical methods as per Ranganna (2014). The pH of the mango pulp and prepared powder (after dilution) was determined with the help of automatic pH meter (Deluxe pH meter model 101). Before estimation, the pH meter was calibrated with buffer solution of pH 4.0 and pH 7.0 (AOAC, 1995), while total and reducing sugars were determined by Lane and Eyon method as given by Ranganna (2014). Acidity was determined by titrating the aliquots against a standardized 0.1 N NaOH solution to a pink end point using phenolphthalein as an indicator (Ranganna, 2014). The rate of dehydration per unit time was calculated by placing a weighed quantity of foamed pulp (600 g) on a stainless steel tray (30 × 20 cm^2) and drying in mechanical dehydrator (60 ± 5 °C) to a constant moisture content (w/w). The loss in weight during drying (% dwb) was calculated by plotting the percent moisture on dry weight basis against time in hours (Ranganna, 2014)

Foaming properties analysis

The Foam density of foamed mango fruit pulp was determined by dividing the mass of the foam by its volume (Falade *et al.*, 2003).

$$\text{Foam Density (g/cm}^3\text{)} = \frac{\text{Mass of the foam, g}}{\text{Volume of the foam, cm}^3}$$

Foam expansion was determined by using following equation (Akiokato *et al.*, 1983).

$$\text{Foam Expansion (\%)} = \frac{V_1 - V_0}{V_0} \times 100$$

Where, V_0 is the initial volume of the mango pulp before foaming (cm^3) and V_1 is the final volume of the mango pulp after foaming (cm^3).

Foam stability was determined according to Marinova *et al*., (2009). The reduction of the foam volume was noted to be used as an index for the determination of the stability for every 30 minutes by using following relationship,

$$\text{Foam Stability (\%)} = \frac{V_0}{V_1} \times 100$$

Where, V_0 is the final volume of the mango pulp after 2 hours of foaming and V_1 is the initial volume of the mango pulp after foaming

Sensory microbiological and statistical analysis

Ninepoints hedonic scale method as suggested by Amerine *et al.,* (1965) was followed for conducting the sensory evaluation of foam mat dried papaya powder. Total plate count (TPC) was estimated by aseptically inoculating 0.1 gram of serially diluted sample (powder) in total plate count/standard plate count agar medium prepared according to Ranganna (2014). The data pertaining to sensory evaluation of papaya powder were analyzed according to Randomized Block Design (RBD) as described by Mahony (1985), while the data on physico-chemical characteristics of fruit, fruit pulp and instant powder were analyzed statistically by following Completely Randomized Design (CRD) of Cochran and Cox (1967).

Results and Discussion

Physico- chemical characteristics of mango fruits

Physical characteristics of *Amrapali, Dashehari, Mallika and seedling mango* are shown in Table-1. Mango cultivars showed highly significant differences in physical parameters Thelength and diameter in all the four cultivars of mango fruits varied from 5.80 to 11.35 cm and 4.71 to 7.10 cm, respectively. This probably shows that highest and lowest being for Mallika and seedling mango respectively. Seedling mangoes were smallest in size with only 5.80 length and 4.71 cm diameter. These values are in the same range as reported earlier (Mishra *et al.,* 2014; Hada and Singh, 2018 and Bains and Dhilon, 1999).The weight of different cultivars of mango fruits varied between 80.18 to 350.02 g Chanana *et al.,* (2005) also recorded higher fruit weight (357.44g/fruit) in cv. *Mallika*. According to Harshitha *et al.,* (2016) average weight of mango fruits varied between 273 to 494 g. Further, Seedling mangoes are smaller in weight and size in comparison to improved cultivated varieties. Seeding mangoes are considered to possess thick peel and large stone in comparison to cultivated varieties. Accordingly, Seedling mangoes had highest percentage of peel (21.00 %) in comparison to other three varieties which showed the peel percentage in the range of 13.50 to 15.42 % (Table 1). Vijayanand *et al.,* (2015) recorded 14.8 % peel content whereas Mishra *et al.,* (2014) have recorded 10.67 % peel percentage in *Mallika*. According to Gowda *et al.,* (1995) peel content of different varieties of mango fruit varied between 13 to 21 %. Keeping in view the weight and size of fruits of different cultivars under study, the pulp recovery ranged between 69.21 to 76.30 % in *Dashehari*, *Amrapali* and *Mallika* cultivars of mango. *Mallika* fruits gave the highest pulp (76.30 %) while Seedling mangoes resulted in lowest pulp yield (56.46 %) in comparison to other varieties (Table 1). Our results are similar to the findings of Mishra *et al.,* (2014) who have reported 73.68% pulp percentage in cv. *Mallika* whereas, Vijayanand *et al.,* (2015) reported 75.3 % pulp content in cv. *Mallika*. Xess *et al.,* (2018) recorded 72.1g fruit weight in *Amrapali.* According to Harshitha *et al.,* (2016) average pulp yield of mango fruits varied between 72.6 to 78.7 %. Seeding mangoes are considered to possess large stone in comparison to cultivated varieties. Accordingly, Seedling mangoes had highest percentage of stone (22.54 %) in comparison to other three varieties which showed the stone percentage in the range of 10.20 to 16.49 % (Table 1). Vijayanand *et al.*, (2015) reported 10.7 % seed content in *Mallika* and 11.88 % in cv. *Amrapali* by Hossain *et al*., (2001).It is evident from Table 1 that the colour appearance of *Amrapali* and Seedling mango fruit was green whereas *Mallika* and *Dashehari* fruit had yellowish green colour. Ara *et al.*, (2014) has also observed green colour in *Amrapal*i cultivar fruits whereas cv. *Mallika* fruit had yellowish green colour.

Chemical characteristics

Total soluble solids

A perusal of data in Table 2 indicates that total soluble solids among different cultivars of mango fruits varied from 13.26 °B to 16.05 °B. Maximum total soluble solids were recorded in cv. *Amrapali* (16.05 °B) and minimum in Seedling mango (13.26 °B). Ara *et al.*, (2014) has reported 20.55 % and 11.87 % TSS in *Amrapali* and *Mallika* varieties of mango, respectively.

Titratable acidity

Titratable acidity among different cultivars of mango fruits varied from 0.14 % to 0.31% (Table 2). Maximum titratable acidity of the fruit was recorded in Seeding mango (0.31%) and minimum in cv. *Dashehari* (0.14%). These results are on the similar lines obtained by Singh *et al.*, (1976) and Xess *et al.*, (2018). Safdar *et al.*, (2012) observed wide variation in the titratable acidity of different cultivars of mango which is attributed to their inherent characteristics and ripening stages.

pH

It is evident from Table 2 that mean pH among different cultivars ranged from 3.82 to 4.44. Maximum pH was recorded in cv. *Amrapali* as 4.44 and minimum in Seedling mango (3.82). These results are in conformity with the findings of Xess*et al.*, (2018) who observed pH as 3.75 in *Totapuri* and 4.32 in *Amrapali* and Vijayanand *et al.*, (2015) observed that pH of *Mallika* cultivar was 4.0.

Ascorbic acid

Perusal of data in the Table 2 shows that Seedling mangoes possessed highest ascorbic acid content (30.12 mg/100 ml) in comparison to other three varieties which showed ascorbic acid content in the range of 16.58 in *Dashehari* to 20.78 mg/100 ml in *Amrapali*. Mishra *et al.*, (2014) has observed highest ascorbic acid in cv. *Amrapali* (21.0 mg/100g) followed by *Mallika* (20.0 mg/ 100g) and *Dashehari* (19.5 mg/ 100g).

Total carotenoids

Data given in Table 2 shows thattotal carotenoids among different cultivars of mango fruits ranged from 1.57 mg /100 ml to 2.91 mg /100 ml. Maximum total carotenoids were recorded in cv. *Dashehari* (2.91 mg/100ml) while Seedling mango exhibited comparatively lower carotenoids (1.57 mg/100 ml). Mishra *et al.*, (2014) reported highest beta carotene in cultivar *Amrapali* (5.4 mg/100gm) followed by *Mallika* (5.3 mg/100g) and *Dashehari* (3.7mg/100g).

Reducing sugars

Perusal of data mentioned in the Table 2 shows that reducing sugars of different cultivars of mango fruits varied from 5.06 % to 6.14 %. Maximum reducing sugars were recorded in cv. *Amrapali* as 6.14 %, and minimum in Seedling mangoes (5.06 %). Mishra *et al.*, (2014) reported higher reducing sugar in cv. *Mallika* (6.2 %) followed by *Amrapali* (6.1 %) and *Dashehari* (5.0 %) whereas lower reducing sugar have been reported by Sharma *etal*., (1999) as 3.87% in cv. *Dashehari*, and in cv. *Langra* and *Mallika* as 3.95% and 3.00% respectively, by Chanana *et al.*, (2005).

Total sugars

It is evident from Table 2 that total sugars ranged from 12.42 to 15.03 % in different cultivars of mango fruits. Highest total sugars were observed in cv. *Amrapali* (15.03 %) followed by *Mallika* and *Dashehari* whereas Seedling mango contained comparatively lowest total sugars (12.42 %). Mishra *et al.*, (2014) reported highest total sugar in cv. *Mallika* (18.5 %) followed by *Amrapali* (17.0 %) and *Dashehari* (15.2 %). According to Shafique *et al.*, (2006) ripe stage had higher sugar content as compared to immature and mature stages in mango fruits.

Effect of carboxy methyl cellulose concentrations on foaming characteristics of pulp of different cultivars of mango

Carboxy methyl cellulose concentrations significantly affected the foaming characteristics.

Results of foam density, foam expansion and foam stability of the mango cultivarsare shown in Figure 2, 3 and 4 . An increase in Carboxy methyl cellulose concentration resulted in an increase in foam expansion ,foam stability and a decrease in foam density in all cultivars used in this study. As expected foam prepared by using 2 % CMC had the lowest foam density and maximum foam expansion and foam stability in among different cultivars of mango pulp .Mango pulp foams of different cultivars with a higher concentration of carboxy methylcellulose (lower density) exhibited higher stability or lower amount of liquid released from the foam than foams with a lower concentration of carboxy methylcellulose with higher density. This is because carboxy methyl cellulose reduces surface tension and interfacial tension in an aqueous system. Furthermore, it encourages the formation of a strong film and stabilizes the interfacial film of the foam system mango pulp foam samples containing higher amount of carboxy methylcellulose, therefore exhibited lower density, higher expansion and higher stability. The results of current study are in agreement with the work of Rajkumar *et al.*, (2007) who reported that as the concentrations of egg albumin (5 to 15%), the foam density of mango pulp decreased from 0.60 g/ cm^3 to 0.51g/ cm^3. Among different cultivars of mango fruit, the mean foam expansion was recorded highest in cv. *Amrapali* (17.50 %) whereas minimum in Seedling mango (10.82 %). However, the interaction between cultivars and different concentrations of foaming agent significantly varied from 2.47 % to 27.51 %. Earlier Rajkumar and Kailappan (2006) recorded 70.5-101.2 per cent foam expansion in *Totapuri* mango pulp. It is evident from Figure 3 that among different concentrations of foaming agent, the mean foam stability was recorded maximum (100 %) in mango pulps which was treated with 2% CMC. Whereas, pulps whipped without using foaming agent (control) did not show any foam stability. Further, the foam stability increased with an increase in foaming agent concentration. Among different cultivars of mango fruit, the mean foam stability ranged between 66.27 to 66.64 % which is considered a desirable attribute. However, interaction between cultivars and foaming agent concentrations was found to be significant which ranged between 0 to 100 %. The maximum foam stability was recorded in a treatment combination of different cultivars and different concentration of foaming agent in all the cultivars (100 %) with 2% CMC while using 1% CMC the foam stability was slightly lower. Similar findings have been reported by Rajkumar and Kailappan (2006) in *Totapuri* mango pulp with foam stability 96.4-98.2 % and Affandi *et al.*, (2017) in *Nigella sativa* beverage ranging from 71.00 - 100.00 %, respectively.

Drying time

Data presented in Table 3 reveal that among different concentrations of foaming agent, the mango pulps foam obtained without CMC (control) took longer time (8.48 hrs) for drying as compared to the foam which was prepared by using 2 % CMC which took only 7.67 hrs. for drying to desired moisture content. It was observed that the drying time of mango pulps of all cultivars decreased when the concentration of foaming agent was increased. Among different cultivars of mango fruit, the mean maximum drying time was taken by foam of mango pulp of cv. *Mallika* (8.54 hrs) followed by Seedling mango (7.97 hrs), *Amrapali* (7.90 hrs.) and *Dashehari* (7.75 hrs). However, the interaction between cultivars of mango fruits and different concentrations of foaming agent significantly varied from 7.45 to 9.02 hrs. Kandasamy *et al.*, (2014) reported that drying time required for foamed papaya pulp was lower than non-foamed pulp at all selected temperatures. Sharma *et al.*, (2002) also found that juice concentrate of 45 °Brix with 2-3% CMC to a moisture content of about 5% took 10 hrs whereas juice concentrate of different folds without addition of stabilizer took 13.50 to 20.30 hrs for drying.

Effect of CMC concentrations on physicochemical properties of foam mat dried mango pulp

A perusal of data in Table 4 indicates that among different concentration of foaming agent, the mean highest powder yield was recorded (14.84 %) in mango pulps which were treated with 2% CMC and minimum by control treatment with a yield (14.53%). It was observed that powder yield percentage increased with the increase in foaming agent concentration. Among different cultivars of mango fruit, the mean powder yield was recorded maximum in cv. *Mallika* (14.96 %) whereas minimum powder yield percentage was found in Seedling mango (13.93 %). However, interaction between cultivars and foaming agent concentration was found to be significant which ranged between 13.72 and 15.10 %. Similar results are reported by Sharma *et al.*, (2002) in foam mat dried hill lemon powder which was increased with increase in concentration of foaming agent.

Total soluble solids (TSS)

The data pertaining to total soluble solids of mango powder of different cultivars presented in Table 5 reveal that among different concentrations of foaming agent, the mean total soluble solids ranged between 81.63 °B to 82.28 °B. It was observed that total soluble solids increased with the increase in foaming agent concentration. Among different cultivars of mango, the mean total soluble solids were recorded maximum in cv. *Amrapali* powder (83.36 °B) whereas minimum in Seedling mango powder (80.76 °B). However, interaction between cultivars and foaming agent concentrations was found to be significant and varied from 80.50 °B to 83.70 °B. Shaari *et al.*, (2017) also observed similar increasing trend in total soluble solids (7.33-8.10°B) with increase in foaming agent (egg albumen) concentrations (0-20%) and in TSS (94.05-94.97°B) of foam mat dried hill lemon juice powder prepared by using different levels of juice concentrates (0 to 45°B) with CMC (1-3%) by Sharma *et al.*, (2002).

pH

Data presented in Table 5 show that among different concentrations of foaming agent, the mean maximum pH was recorded a maximum of (4.58) in mango pulps treated with 2%

CMC and minimum (4.51) in control treatments. Among different cultivars of mango fruit, the mean maximum pH was recorded in cv. *Mallika* (4.75) while minimum was recorded in Seedling mango (4.05). Among different cultivars and foaming agent concentrations the pH of the powder ranged between 4.00 and 4.79. The difference in pH value of different varieties might be attributed to the presence of inherent acidity in the represented pulps. However, interaction between cultivars and foaming agent concentrations was found to be non significant. Gradual increase in pH (3.99-4.54) in foam mat dried pineapple fruit has also been reported by Shaari *et al.,* (2017).

Titratable acidity (%)

A perusal of data in Table 5 indicates that among different concentrations of foaming agent (0-2%), the mean titratable acidity in mango powders ranged between 1.05 to 1.26 % as citric acid. It was observed that titratable acidity decreased with an increase in foaming agent concentration. Among different cultivars of mango fruit, the mean titratable acidity of mango powders was recorded maximum in Seedling mango (1.38 %) whereas minimum titratable acidity percentage was found in cv. *Amrapali* (1.03 %). With respect to interaction between among different cultivars and foaming agent concentrations, the titratable acidity ranged between 0.94 % to 1.53 % and found to be significant. Similar trend in titratable acidity 0.279-0.557 per cent in mandarin powder has been reported by Kadam *et al.,* (2011) and 57.69-44.06 per cent in hill lemon juice powder by Sharma *et al.,* (2002).

Moisture content (%)

Data presented in Table 6 show the effect of different concentrations of foaming agent (carboxy methyl cellulose) on moisture content of mango powder of different cultivars. The data reveal that among different concentration of foaming agent, the mean moisture content ranged between 5.57 to 6.08 %. Among different cultivars of mango fruit, the mean moisture content of the powder was recorded maximum in cv. *Mallika* (5.93 %) followed by cv. *Amrapali* (5.74 %). However, interaction between cultivars and foaming agent concentration was found to be non significant. The maximum moisture was observed in cv. *Mallika* powder (6.19 %) without CMC and the minimum moisture content was observed in cv. *Amrapali* powder (5.50 %) treated with 2% CMC. As the foaming of pulp by addition of 2 % CMC helped in better removal of moisture during drying. Similar to these findings Shaari *et al.,* (2017) recorded 3.91 to 7.91 per cent moisture in pineapple powder and Sharma *et al.,* (2004) reported 5.95-5.65 per cent moisture content in hill lemon juice powder.

Ash content (%)

The data pertaining to ash content of mango powder of different cultivars presented in Table 6 reveal that among different concentrations of foaming agent, the mean ash content was found to be 4.61 % in treatments treated with 2 % CMC and 4.55 % in control treatments of all cultivars. It was observed that the ash content was increased with an increase in concentration of foaming agent. Among different cultivars of mango, the mean ash content was recorded maximum in cv. *Amrapali* powder (4.62 %) whereas minimum was found in Seedling mango powder (4.52 %). Among different cultivars and concentration of foaming agent, the ash content in powders varied between 4.50 % and 4.65 %. Earlier, Patil *et al.,* (2014) has reported opposite trend in ash content (1.5-3.3 per cent) with subsequent increase in malto-dextrin foaming agent concentration (7-12 per cent) in guava powder.

Total carotenoids

Aperusal of data in Table 6 indicate that among different concentrations of foaming agent, the mean total carotenoids was recorded a maximum (12.29 mg/100g) in mango powders without CMC and a minimum of (11.88 mg/100g) in mango powders treated with 2% CMC. It was observed that total carotenoids decreased with an increase in foaming agent concentrations, as CMC is much does not contain carotenoids. Among different cultivars of mango fruit, total carotenoids ranged between 11.93 to 12.22 mg/100g. However, the interaction between cultivars and foaming agent concentration was found to be significant. The maximum total carotenoids were recorded in cv. *Mallika* powder (12.49 mg/100g) without CMC whereas the minimum total carotenoids(11.77 mg/100g) were recorded in Seedling mango powder treated with 2% CMC. Similar trend of decline in total carotenoids was observed by Wilson *et al.,* (2012) in mango powder (16.59-4.25 mg/100g) and Khamjae and Rojanakorn (2018) in passion fruit (83.87-72.51 mg/100g).

Ascorbic acid

Data presented in Table 7 reveal that ascorbic acid content among different concentrations of foaming agent was recorded maximum as 27.27 mg/100g in control treatment (without CMC) and minimum of (27.06 mg/100g) with 2% CMC. It was found that ascorbic acid content decreased with the increase in foaming agent concentration. Among different cultivars of mango fruit, the mean ascorbic acid content was recorded maximum in Seedling mango powder (35.27 mg/100g) while minimum in cv. *Dashehari* powder (23.73 mg/100g). As such Seedling mango powder was considered good source of vitamin C. However, interaction between cultivars and foaming agent concentration was found to be significant and ranged between 23.62 mg/100g to 35.36 mg/100g. Similar trend of reduction in ascorbic acid content has been recorded in foam mat dried hill lemon juice powder by Sharma *et al.,* (2004).

Reducing sugar (%)

The data pertaining to reducing sugar of mango powders of different cultivars presented in Table7 reveal that among different concentrations of foaming agent, the mean reducing sugar ranged between 43.80 to 45.62 % in different concentrations of CMC. It was observed that the reducing sugar increased with an increase in concentrations of foaming agent. Among different cultivars of mango, the mean reducing sugar was recorded maximum in cv. *Amrapali* powder (47.94 %) whereas minimum in Seedling mango powder (41.71 %). However, interaction between cultivars and foaming agent concentrations was found to be significant for the reducing sugar which varied from 40.95 % to 48.62 %. Earlier Akhtar *et al.,* (2010) has also reported increase in reducing sugars 1.40-9.3 per cent from juice to mango juice powder.

Total sugar (%)

A perusal of data in Table 7 indicates that among different concentrations of foaming agent, the mean total sugar was recorded a maximum of 79.30 % in mango powders prepared by using 2% CMC and minimum (75.83 %) in mango powders without CMC. It was observed that total sugar increased with an increase in foaming agent concentrations. Among different cultivars of mango fruit, the mean total sugar was recorded maximum in cv. *Amrapali* powder (78.82 %) and minimum in Seedling mango powder (75.74 %). However, interaction between cultivars and foaming agent concentration was found to be significant for total sugar of mango powders ranging between 73.99 to 80.05 %.

Table.1 Physical characteristics of different cultivars of mango fruit

Parameters / Cultivars	Fruit weight (gm)	Fruit length (cm)	Fruit diameter (cm)	Peel (%)	Pulp (%)	Stone (%)	Colour
Amrapali	188.20± 1.11	9.40 ±0.13	4.73± 0.04	15.42± 0.10	71.37± 0.015	13.25± 0.21	Green
Dashehari	118.44± 0.22	8.47± 0.04	5.52± 0.01	14.30± 0.03	69.21± 0.17	16.49± 0.56	Yellowish Green
Mallika	350.02± 0.98	11.35± 0.14	7.10± 0.04	13.50± 0.19	76.30± 0.27	10.20± 0.12	Yellowish Green
Seedling mango	80.18± 0.35	5.80± 0.12	4.71± 0.03	21.00± 0.19	56.46± 0.34	22.54± 0.33	Green
$CD_{0.05}$	2.332	0.363	0.094	0.451	0.758	1.060	

Table.2 Chemical characteristics of mango pulp of different cultivars

Parameters / Cultivars	TSS (°Brix)	pH	Titratable acidity (% citric acid)	Ascorbic acid (mg/100 ml)	Total Carotenoids (mg/100 ml)	Reducing sugar (%)	Total sugar (%)
Amrapali	16.05± 0.02	4.44± 0.01	0.15± 0.003	20.78± 0.04	1.93± 0.01	6.14± 0.02	15.03± 0.09
Dashehari	15.00± 0.05	4.42± 0.01	0.14± 0.003	16.58± 0.01	2.91± 0.006	5.52± 0.01	13.77± 0.02
Mallika	16.03± 0.08	4.00± 0.05	0.24± 0.006	17.53± 0.02	2.82± 0.006	6.05± 0.01	14.00± 0.06
Seedling mango	13.26± 0.14	3.82± 0.01	0.31± 0.006	30.12± 0.06	1.57± 0.017	5.06± 0.02	12.42± 0.02
$CD_{0.05}$	0.301	0.103	0.016	0.145	0.036	0.064	0.178

Table.3 Effect of foaming agent concentrations on drying time (hours) of mango pulp of different cultivars

Cultivars \ Concentrations	Drying time (hrs)			
	0%	**1%**	**2%**	**Mean**
Amrapali	8.32	7.87	7.51	7.90
Dashehari	8.25	7.54	7.45	7.75
Mallika	9.02	8.34	8.25	8.54
Seedling mang0	8.34	8.09	7.48	7.97
Mean	8.48	7.96	7.67	

CD$_{0.05}$				
	Cultivars (C)	=	0.075	
	Foaming agent concentration (F)	=	0.065	
	C× F	=	0.129	

Table.4 Effect of different concentrations of foaming agent (carboxy methyl cellulose) on powder yield of different cultivars of mango

Cultivars \ Concentrations	Yield (%)			
	0%	**1%**	**2%**	**Mean**
Amrapali	14.80	14.91	15.05	14.92
Dashehari	14.76	14.85	15.01	14.87
Mallika	14.85	14.94	15.10	14.96
Seedling mang0	13.72	13.85	14.23	13.93
Mean	14.53	14.64	14.84	

CD$_{0.05}$				
	Cultivars (C)	=	0.075	
	Foaming agent concentration (F)	=	0.065	
	C× F	=	0.130	

Table.5 Effect of concentrations of foaming agent on TSS, pH and Titratable acidity of mango powder of different cultivars

Concentrations / Cultivars	TSS (^{o}Brix)*				Titratable acidity (%)				pH			
	0%	1%	2%	Mean	0%	1%	2%	Mean	0%	1%	2%	Mean
Amrapali	83.00	83.40	83.70	83.36	1.14	1.02	0.94	1.03	4.70	4.72	4.75	4.72
Dashehari	81.35	81.65	82.00	81.66	1.23	1.17	1.05	1.15	4.65	4.67	4.70	4.67
Mallika	81.70	82.00	82.40	82.03	1.13	1.05	0.95	1.04	4.72	4.76	4.79	4.75
Seedling mango	80.50	80.75	81.05	80.76	1.53	1.36	1.25	1.38	4.00	4.05	4.10	4.05
Mean	81.63	81.95	82.28		1.26	1.15	1.05		4.51	4.55	4.58	
$CD_{0.05}$												
Cultivars (C) =				0.098				0.024				0.050
Foaming agent concentrations (F) =				0.085				0.021				0.043
C×F =				NS				0.042				NS

Note: *for estimation of TSS, 10 g of powder was diluted to 100 ml and resultant value multiplied by factor of 10.

Table.6 Effect of concentrations of foaming agent on Moisture content, Ash content and Total carotenoids of mango powder of different cultivars

Concentrations / Cultivars	Moisture content (%)				Ash content (%)				Total Carotenoids (mg/100g)			
	0%	1%	2%	Mean	0%	1%	2%	Mean	0%	1%	2%	Mean
Amrapali	6.00	5.72	5.50	5.74	4.59	4.62	4.65	4.62	12.42	12.24	11.94	12.20
Dashehari	6.10	5.82	5.55	5.82	4.55	4.57	4.60	4.57	12.15	12.01	11.84	12.00
Mallika	6.19	5.88	5.72	5.93	4.56	4.58	4.63	4.59	12.49	12.20	11.96	12.22
Seedling mango	6.05	5.81	5.51	5.79	4.50	4.53	4.55	4.52	12.09	11.94	11.77	11.93
Mean	6.08	5.80	5.57		4.55	4.57	4.61		12.29	12.10	11.88	
$CD_{0.05}$												
Cultivars (C) =				0.062				0.023				0.061
Foaming agent concentrations (F) =				0.054				0.020				0.053
C×F =				NS				NS				0.105

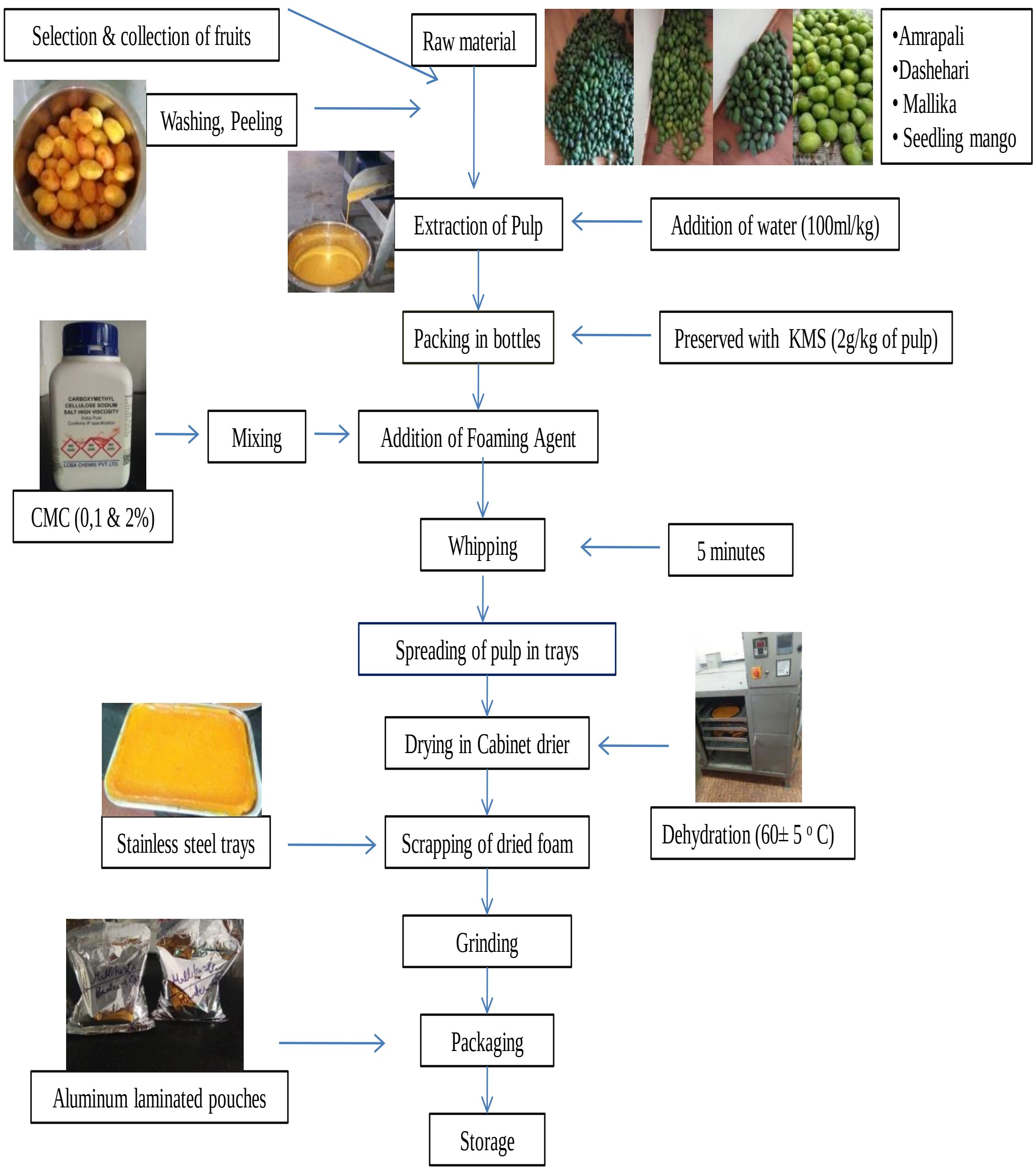
Table.7 Effect of concentrations of foaming agent on Ascorbic acid, Reducing sugar and Total sugar of mango powder of different cultivars

Cultivars \ Concentrations			Ascorbic acid (mg/100g)				Reducing sugar (%)				Total sugar (%)			
			0%	1%	2%	Mean	0%	1%	2%	Mean	0%	1%	2%	Mean
Amrapali			25.05	24.91	24.85	24.93	47.20	48.00	48.62	47.94	77.40	79.00	80.05	78.82
Dashehari			23.82	23.77	23.62	23.73	42.05	42.97	43.14	42.72	75.40	77.00	79.50	77.30
Mallika			24.87	24.67	24.61	24.71	45.00	45.95	46.69	45.88	76.55	78.60	79.90	78.35
Seedling mango			35.36	35.28	35.17	35.27	40.95	41.55	42.62	41.71	73.99	75.50	77.75	75.74
Mean			27.27	27.16	27.06		43.80	44.62	45.26		75.83	77.52	79.30	
$CD_{0.05}$														
	Cultivars (C)	=	0.021				0.044				0.029			
	Foaming agent concentrations (F)	=	0.018				0.038				0.025			
	C×F	=	0.036				0.077				0.050			

Table.8 Sensory evaluation of (9-point hedonic scale) of mango fruit powders of different cultivars prepared by using different concentrations of foaming agent (carboxy methyl cellulose)

Cultivars \ Concentrations			Sensory properties														
			Colour				Taste				Aroma				Overall acceptability		
			0%	1%	2%	Mean	0%	1%	2%	Mean	0%	1%	2%	Mean	0%	1%	2%	Mean
Amrapali			7.80	8.13	8.90	8.28	8.10	8.47	8.67	8.41	7.97	8.50	8.77	8.41	7.95	8.36	8.77	8.36
Dashehari			6.70	6.90	6.97	6.86	7.00	7.13	7.27	7.13	7.03	7.17	7.40	7.20	6.91	7.06	7.21	7.06
Mallika			6.97	7.17	7.40	7.18	7.63	7.67	7.80	7.70	7.60	7.70	7.70	7.67	7.40	7.51	7.63	7.51
Seedling mango			6.03	6.70	6.90	6.55	6.50	6.71	7.00	6.74	6.70	6.75	7.00	6.82	6.41	6.72	6.97	6.70
Mean			6.88	7.23	7.54		7.30	7.49	7.68		7.33	7.53	7.72		7.17	7.41	7.65	
$CD_{0.05}$																	
	Cultivars (C)	=	0.129				0.085				0.100				0.216			
	Foaming agent concentrations (F)	=	0.112				0.074				0.087				0.187			
	C×F	=	0.224				0.147				0.174				NS			

Figure.1 Flow chart for preparation of foam mat dried mango powders



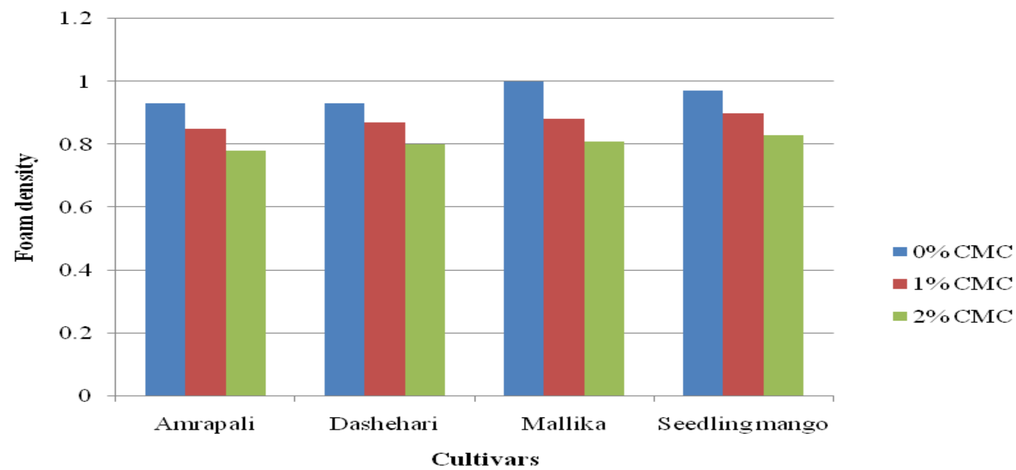


Figure. 2 Effect of foaming agent concentration on foam density of mango pulp of different cultivars

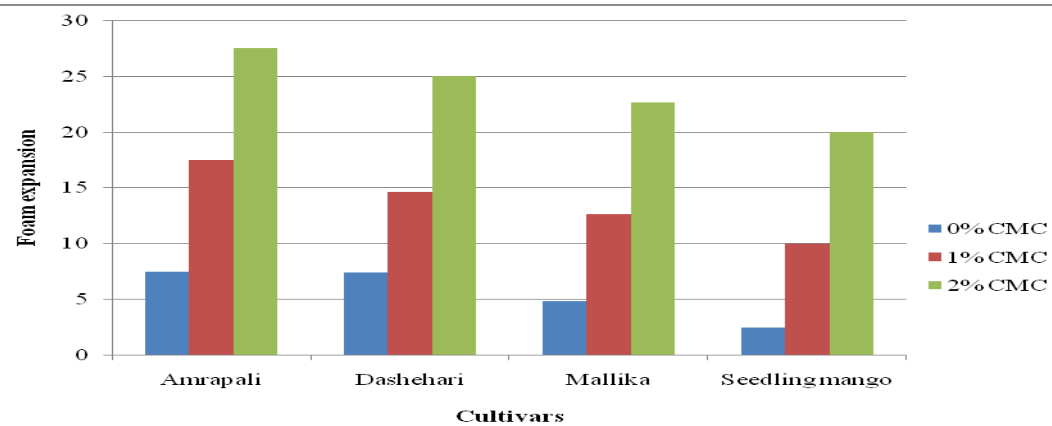


Figure. 3 Effect of foaming agent concentration on foam expansion of mango pulp of different cultivars

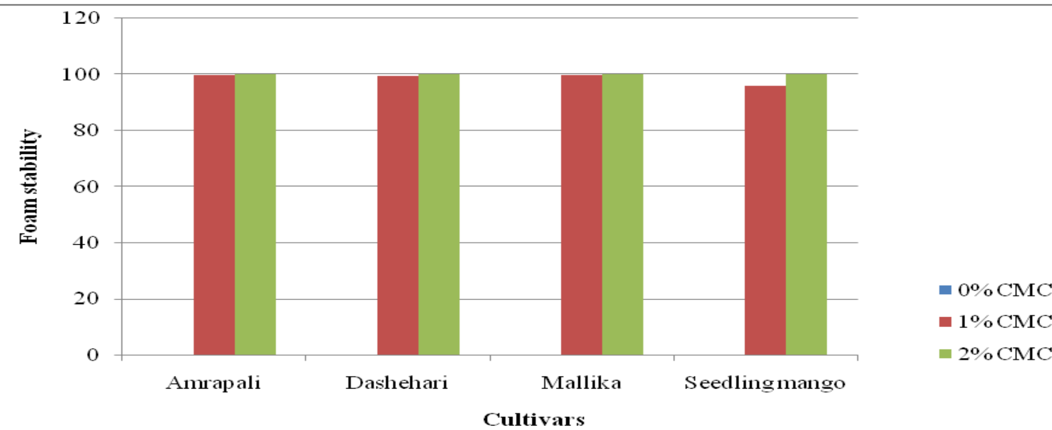


Figure .4 Effect of foaming agent concentration on foam stability of mango pulpsof different cultivars

Earlier Chaves *et al.,* (2013) recorded increase in sugar content of foam-mat Brazilian cherry pulp powder with the addition of foaming agent.

Sensory evaluation of mango powders of different cultivars prepared by using different concentrations of foaming agent (carboxy methyl cellulose)

Mango powder of different cultivars was evaluated for various sensory attributes on a 9 point hedonic scale. The data presented in Table 8 is discussed as under:-

Colour

The data recorded for mean colour score remained highly significant within all concentrations of CMC in different mango cultivars (Table 8). With an increase in concentrations of foaming agent, the colour acceptability of the mango powder exhibited increase on a 9 point hedonic scale ranging from 6.88 to 7.54. Among different cultivars colour score was recorded highest for *Amrapali* (8.28) and lowest for Seedling mangoes (6.55). Among different cultivars and concentrations of foaming agent, highest colour score (8.90) was recorded in cv. *Amrapali* with 2% CMC and lowest in Seedling mango (6.03) without CMC.

Taste

Data presented in Table 8 shows that among different concentrations of foaming agent the mean taste score ranging from 7.30 to 7.68. The taste acceptability is increased with an increase in concentrations of foaming agent. Among different cultivars the highest taste score was recorded in cv. *Amrapali* (8.41) and lowest in Seedling mango (6.74). Among different cultivars and concentration of foaming agent ranging from 6.50 to 8.67 and found significant for taste. Highest taste score (8.67) was recorded in cv. *Amrapali* with 2% CMC and lowest in Seedling mango (6.50) without CMC.

Aroma

Aperusal of data in Table 8 shows that among different concentrations of foaming agent the mean aroma score ranging from 7.33 to 7.72. The aroma acceptability was observed to increased with an increase in concentrations of foaming agent. Among different cultivars the highest aroma score was recorded in cv. *Amrapali* (8.41) and lowest in Seedling mango (6.82). Among different cultivars and concentration of foaming agent the interaction was found significant for aroma ranging from 6.70 to 8.77. Highest aroma score (8.77) was recorded in cv. *Amrapali* with 2% CMC and lowest in Seedling mango (6.70) without CMC. The interaction between cultivars and foaming agent found to be significant for aroma.

Overall acceptability

Data presented in Table 8 shows that among different concentrations of foaming agent the mean overall acceptability score ranging from 7.17 to 7.65. An increasing trend was obtained for overall acceptability with the increase in concentrations of foaming agent. Among different cultivars the highest overall acceptability score was recorded in cv. *Amrapali* (8.36) and lowest in Seedling mango (6.70). Among different cultivars and concentrations of foaming agent highest overall acceptability score (8.77) was recorded in cv. *Amrapali* with 2% CMC and lowest in Seedling mango (6.41) without CMC.

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How to cite this article:

Namita Rani, Anil Kumar Verma, P.C. Sharma, Raj Saini and Shivani. 2020. Composition and Characterization of Foam Mat Dried Powder Prepared From Seedling and Cultivated Mango Cultivars of Himalayan Region. *Int.J.Curr.Microbiol.App.Sci.* 9(05): 593-611.
doi: https://doi.org/10.20546/ijcmas.2020.905.067