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Development of Mango and Mint Leaves Powder by using different Drying Techniques -A Comparative Study

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ABSTRACT: Drying is one of the oldest methods of preservation and involves removal of relatively small proportions of water by thermal means via the vapor phase. Drying is a simultaneous heat and mass transfer process. Dried foods can be stored for long periods without deterioration occurring. This eventually results in shelf-stable products with improved packaging and transportation properties. Kale pyri variety of mango powder is rich in Vitamin-C and antioxidants. Spear mint powder is particularly good source of Vitamin-A. The three drying techniques are tray, solar and microwave dryings are compared and analysed the moisture, fat, ash in both mango and mint leaves powder and also vitamin C in mango powder and chlorophyll, carotenoids in mint leaves powder were estimated. Trays drying of mango at different drying treatments are following T1, T2 & T3 is 45°C for 6.5 hours, 50°C for 6 hours & 60°C for 5 hours respectively. Trays drying of mint leaves at different drying treatments are following T1, T2 & T3 at 30°C for 3 hours, 60°C for 2 hours & 50°C for 4 hours respectively. The results showed that the tray drying of mango and mint leaves are better quality parameters in dried powders as compared to solar and microwave drying. The importance of drying and techniques to dry the mango slices and mint leaves and nutritional values of different drying techniques were discussed in this paper.

Keywords: Mangoes, Mint leaves, solar drying, microwave drying and tray drying.

INTRODUCTION

Drying is one of the essential unit operations performed to increase the shelf life of agricultural/horticultural produce and it is one of the most practical methods of preserving food and the quality of horticultural produce. If the drying process is not completed fast enough, growth of microorganisms will take place as a result of the high relative humidity. Open sun drying also requires a large space. Drying is usually conducted by vaporizing water in the product. In this case, drying at low temperature and humidity is required to maintain the fresh color of the product using the desiccant system. The same product dried with different techniques produces different levels of product quality (Kumar *et al.*, 2017).

Drying is a common technique for preservation of food and other products; including fruits and vegetables. The major advantage of drying food products is the reduction of moisture content to a safe level that allows extending the shelf life of dried products. The removal of water from foods provides microbiological stability and reduces deteriorative chemical reactions. Also, the process allows a substantial reduction in terms of mass, volume, packaging requirement, storage and transportation costs with more convenience (Okos *et al.*, 1992).

Drying might be a suitable technique to prolong the shelf life of kiwi. which is susceptible for microbial spoilage and softening due to its high moisture content Fruit juices purees and powders are being marketed due to an increased demand for ready-to eat foods In addition powder products with a long-term ambient shelf life and microbiological stability can reduce the transportation and storage costs as well (Jinapong *et al*., 2008).

Mint (*Mentha spicata* L.) is a common name for members of the Labiatae (Laminaceae Family). Green leaves of the plant are used for flavoring culinary preparations, vinegar, jellies and iced drinks. Mint leaves are known for refreshing, antiseptic, antiasthmatic, stimulative, diaphoretic, stomachic, and antispasmodic features. Various authors (Park *et al*., 2002) have indicated the use of mint leaves in variety of dishes such as vegetable curries, chutney, fruit salads, vegetable salads, salad dressings, soups, desserts, juices, sherbets etc. (Satyanarayana *et al*., 2001).

The present study is on “Development of Mango and Mint Leaves Powder by Using Different Drying Techniques”. It is a comparative study. It includes Standardizing the procedure for development of mango and mint leaves powder. Comparison of nutrient composition and shelf-life studies at different drying techniques.

MATERIAL AND METHOD

A. Raw materials

Raw materials like mangoes and mint leaves were purchased from the local market at Varni and Bodhan.

B. Equipment and Instruments

The Equipment are solar dryer, tray dryer, microwave dryer, weighing balance, grinder, hot air oven, muffle furnace, soxhlet apparatus, Ultra violet – visible spectrophotometer, water bath, autoclave, laminar air flow, incubator obtained from College of Food Science and Technology, Rudrur.

C. Methods

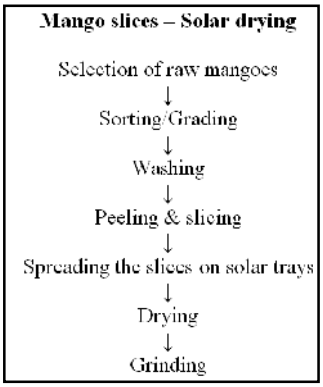

Fig. 1. Flow chart for solar drying of mango slices.

Fig. 2. Flow chart for solar drying of mint leaves.

Fig. 3. Flow chart for Tray drying of mango slices.

Fig. 4. Flow chart for Tray drying of mint leaves.

Fig. 5. Flow chart for microwave drying of mango slices.

Fig. 6. Flow chart for microwave drying of mint leaves.

(i) Estimation of Moisture. Moisture is done by oven drying method (AOAC, 2005). In oven drying method, the sample is heated under specified conditions, and the loss of weight is used to calculate the moisture content of the sample. Weigh the empty Petri dish. Take 5 g of the sample and placein weighed empty Petri dish. Note the weight (Petri dish + sample) (W_1). Pre heat the oven to 100°C. Now place the sample in the oven at 105ºC± 2°C for 3 to 4 hours. Take the sample from the hot air oven and place it in desiccators for some time. Weigh the sample (dried sample + Petridish) (W_2). Calculate the moisture percentage by the following formula.

$$\% \text{ Moisture} = W_2 - W_3 \times 100 / W_2 - W_1$$

(ii) Ash content. The finely ground sample of 5g was weighed in pre-weighed silica crucible and ignited till smokeless. Then it was transferred to muffle furnace and heated at 550°C for 4 hours for complete oxidation

of organic matter and resultant ash content was calculated (AOAC, 2005).

Ash content (%) = $W_3 - W_2 \times 100 / W_1$

W_1 = weight of sample

W_2 = weight of crucible

W_3 = weight of crucible after combustion

(iii) Fat Estimation. Fat is estimated from crude ether extract of the dry material. The dry sample (5 – 10g) is weighed accurately into thimble & plugged with cotton. The thimble is then placed in soxhlet apparatus and extracted with anhydrous ether for about 16hrs. The ether extract is filtered intoa weighed conical flask. The flask containing the ether extract is washed 4 to 5 times with small quantities of ether in the washings is also transferred. The ether is then removed by evaporation and the flask with the residue dried in an oven at 80 – 100°C cooled in desiccators and weighed (AOAC, 2005).

Fat content (gm /100 sample)

$$= \frac{\text{Weight of ether extract}}{\text{Weight of the sample}} \times 100$$

(iv) Chlorophyll Estimation. Estimation of chlorophyll in fresh and dehydrated mint leaves was carried out accordingto the procedure of the sample (0.5-1.0 g) was macerated with acetone in a pestle and mortar. The supernatant layer was decanted and the extraction was repeated until the residue was colourless. The extracts were then pooled, filtered and made up to 100 ml in a volumetric flask. About 25-50 ml aliquot of the acetone extract was taken into a separating funnel and mixed with 50 ml diethyl ether and water was added until the water layer was apparently free of all the fat-soluble pigments. The water layer was drained off and the ether layer washed with25 ml portions of distilled water until the layer was free of acetone. The ether layer was taken into a 50 ml volumetric flask. 3-4 g of anhydrous sodium sulphate was added to remove the moisture. The absorbance was taken at wavelengths of 660 and 642.5 nm. Total chlorophyll = 7.12 × O.D at 660nm + 16.8 × O.D at 642.5nm; Chlorophyll ''a''= 9.93 × O.D. at 660nm - 0.777 × O.D at 642.5nm; Chlorophyll ''b''= 17.60 × O.D. at 642.5 nm - 2.81 × O.D at 660 nm.The above equations provide chlorophyll content in mg/l in the solution used for recording absorbance. The chlorophyll content in the mint samples was calculated taking the dilution factor into consideration, and the results were expressed as mg/100 g on dry basis. (Ranganna, 2010).

(v) Extraction of Carotenoid. The estimation of total carotenoids was done after extraction of the sample (1g) with acetone and further purification with petroleum ether and distilled water. The resulting solution was filtered with anhydrous sodium sulphate and read on a spectrophotometer at 452 nm against petroleum ether as a blank.

(vi) Estimation of Ascorbic Acid by volumetric method. Ascorbic acid otherwise known as Vitamin C is antiscorbutic. It is present in citrus fruits, gooseberry, bitter gourd etc. in high amount. Generally it is present in all fresh vegetables andfruits. It is water soluble and heat-labile vitamin. The method is used to estimate Ascorbic Acid is suggested by Sadasivam and Balasubraminan (1987); Harris and Roy (1935)

D. Shelf life studies

(i) Microbial Analysis of mango and mint leaves powder. Microbial population of samples particularly bacterial, fungal and yeast load, standard procedures of serial dilution and plate count as described by Adegoke, 2004 and Hasanuzzaman, 2014 was used with slight modifications as most suitable to our laboratory conditions. All media and equipment were sterilized in the autoclave at 121°C, pressure of 15 psi for 20 minutes. The media used for bacterial count is nutrient agar media and for yeast and mold count is potato dextrose agar. Then, one gram of each sample was aseptically weighted into a 25 ml test tube and distilled water added to the 10 ml mark and vortexed vigorously and it was repeat until five dilutions.

Standard plate count was estimated by decimal dilution technique followed by the spread plate method for bacteria, yeast and mold. In spread plate method, 15 to 20ml of pre- autoclaved media was poured in a sterilized petri plate and kept under room temperature until the agar became solid. In agar plates 0.1ml of the sample of last three dilutions was dropped and the sample was spread on the agar plate with the help of sterilized glass rod. The plate was then incubated at the 37°C temperature for 48 hours for bacterial growth and for yeast and mold growth it kept at 28-30°C for 24 hours. All steps of this media preparation were done under laminar airflow.

RESULTS AND DISCUSSION

A. Standardizing the procedure for mango and mint leaves powder

The procedure for development of mango and mint leaves powder were standardized based on the different drying treatments are T1, T2, T3 for each drying techniques (solar, tray and microwave drying).

(i) Drying of mango slices through solar, Tray and Microwave drying techniques. The preparation of mango powder through solar drying, mangoes were sorted to remove the stems or foreign matter and graded according their shape and size followed by washed under running water and raw mangoes were peeled to remove the outer green layer and deseeded by using a stainless steel knife. The peeled flesh is cut into slices by using a slicer. They were spread on solar trays and dried in solar dryer .The final dried slices ground into fine powder and stored in glass container (Norhadi *et al.*, 2020).

The Table 1 shows that, solar drying of mango at different drying treatments are following T1 at 70 ± 2°C for 3 hours, after grinding obtained sample is 232g/kg, T2 at 75±3°C for 2 hours after grinding obtained sample is 227.5 g/kg and T3 at 60±3°C for 4 hours after grinding obtained sample is 236.6 g/kg. The T1 sample is got burnt smell and T2 sample is found very much burnt due to high temperature and moisture is removed in T3 sample compare to T1 & T2. Among these treatments it is concluded that T3 is best sample recorded by the visual appearance and weight of the

sample obtained is more compared with T1 & T2 samples. As shown in Fig. 7.

Tray drying of mango at different drying treatments are following T1, T2 & T3 is 45°C for 6.5 hours, 50°C for 6 hours & 60°C for 5 hours respectively (Table 1 and Fig. 7). The weight obtained at three different drying techniques were 220.5g, 217.4g, and 210g per kg for T1, T2 and T3 respectively. At T1 and T2 treatment slices were not dried properly whereas T3 treatment found best, because moisture is removed. It is concluded that T3 is best among all drying treatments by visual appearance.

Microwave drying of mango at different drying treatments are following T1 at 450w for 14 minutes, after grinding obtained sample is 157.2g/kg, T2 at 600wfor 11minutes after grinding obtained sample is 160 g/kg and T3 at 900w for 5 minutes after grinding obtained sample is 154.7g/kg. In the T1 sample has burnt smell and T3 sample is color changed due to high temperature, whereas T2 sample found good when compared with other two treatments. Among these treatments it is concluded that T2 is best sample recorded by the visual appearance and weight of the sample obtained is more compared with T1 & T3 samples (Table 1 and Fig. 7).

Table 1: Drying of mango slices through different drying techniques

Sr. No.	Parameters	Solar drying			Tray drying			Microwave drying		
		T1	T2	T3	T1	T2	T3	T1	T2	T3
1.	Temperature (°C)	70 ± 2	75 ± 3	60 ± 3	45	50	60	450	600	900
2.	Time (hours)	3	2	4	6.5	6	5	14	11	5
3.	Weight(g/kg)	232.0	227.5	236.6	220.5	217.4	210	157.2	160	154.7

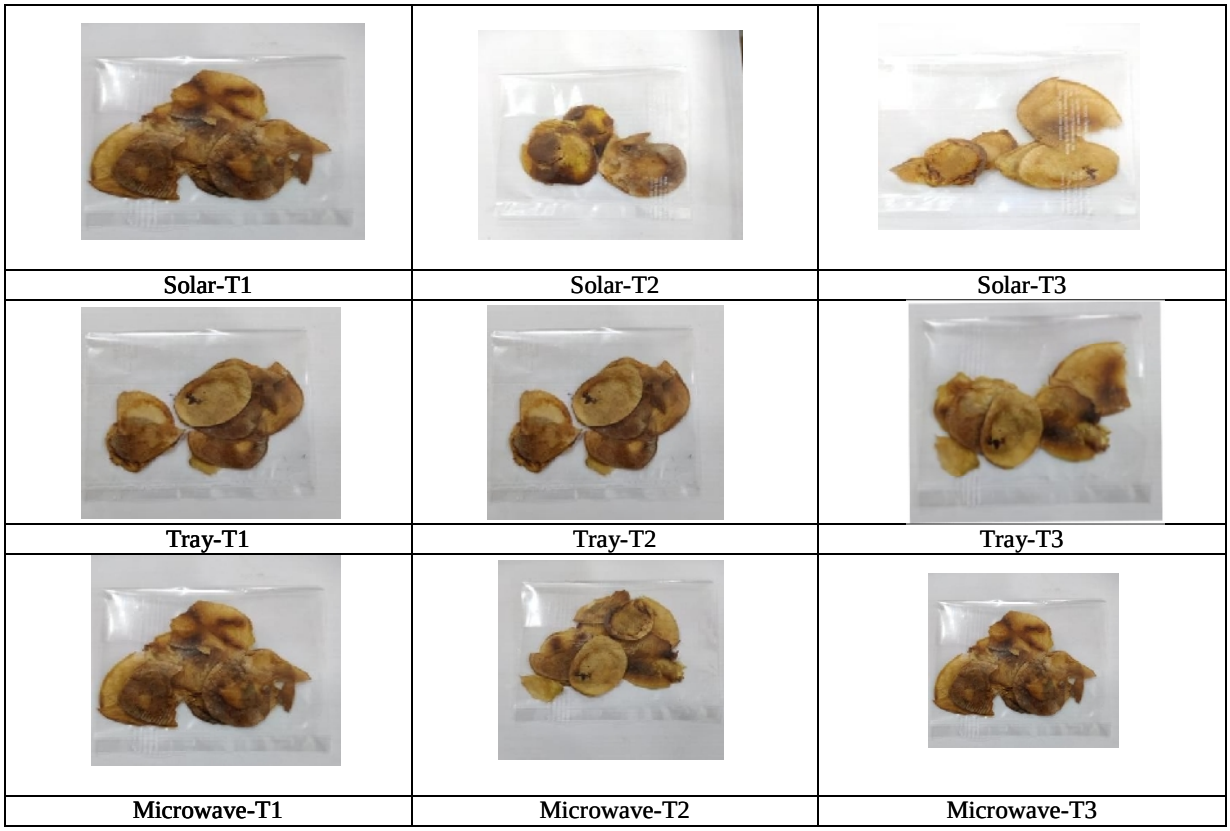

Fig. 7. Dried mango slices through different treatments with 3 drying techniques.

(ii) Drying of mint leaves through solar, Tray and Microwave drying techniques. Solar drying of mint leaves was carried out in solar dryer. Primarily the leaves were taken followed by washing to remove dirt and leaves were plucked from stalks. The cleaned and plucked mint leaves are spread on solar trays and dried. After drying slices grounded into fine powder and stored in air tight glass container. (Raviteja *et al*. 2019)

The Table 2 shows that, solar drying of mint leaves at different drying treatments are following T1 at 52 ± 2°C for 1.5 hours, after grinding obtained sample is 159.4g/kg, T2 at 75±3°C for 2 hours after grinding obtained sample is 150.6 g/kg and T3 at 45±3°C for 1 hour after grinding obtained sample is 166.1 g/kg. In the T1 sample is got burnt smell and T2 sample is found very much chared due to high temperature, whereas T3 sample found good when compared with other two treatments. Weight of the sample obtained is more compared with T1 & T2 samples. Among these treatments it is concluded that T3 is best sample recorded by the visual appearance and weight of the

sample obtained is more compared with T1 & T2 samples (Fig. 8).

Table 2 represents that, tray drying of mint leaves at different drying treatments are following T1, T2 & T3 at 30°C for 3 hours, 60°C for 2 hours & 50°C for 4 hours respectively. The weights are obtained at three different techniques were 254g, 251g, 250.5g per kilogram for T1, T2 and T3 respectively. After three drying treatments, the T1 treatment of mint leaves are dried uniformly and acceptable in weights for preparation of powder. So, this T1 treatment of mint leaves found best when compared to T2 and T3 treatments. As shown in the Fig. 8.

The mint leaves drying was carried out in microwave oven. The moisture loss was recorded at 30sec intervals. The leaf sample is weighed till constant weight is attained and grounded into fine powder and stored.

Microwave drying of mint leaves at different drying treatments are followed T1, T2 & T3 at 600w for 8 minutes, 450w for 11 minutes & 900w for 5 minutes respectively. The weights are obtained at three different techniques were 232.3g, 235.3g, 230g per kg for T1, T2 and T3 respectively. After drying among these treatments observed that T1 is best sample recorded by the visual appearance when compared with T2 &T3 treatments (Table 2 and Fig. 8).

Table 2: Drying of mint leaves through different drying techniques.

Sr. No.	Parameters	Solar drying			Tray drying			Microwave drying		
		T1	T2	T3	T1	T2	T3	T1	T2	T3
1.	Temperature (°C)	52 ± 2	75 ± 3	45 ± 3	30	60	50	600	450	900
2.	Time (hours)	1.5	2	1	3	2	4	8	11	5
3.	Weight(g/kg)	159.4	150.6	166.1	254	251	250.5	232.3	235.3	230

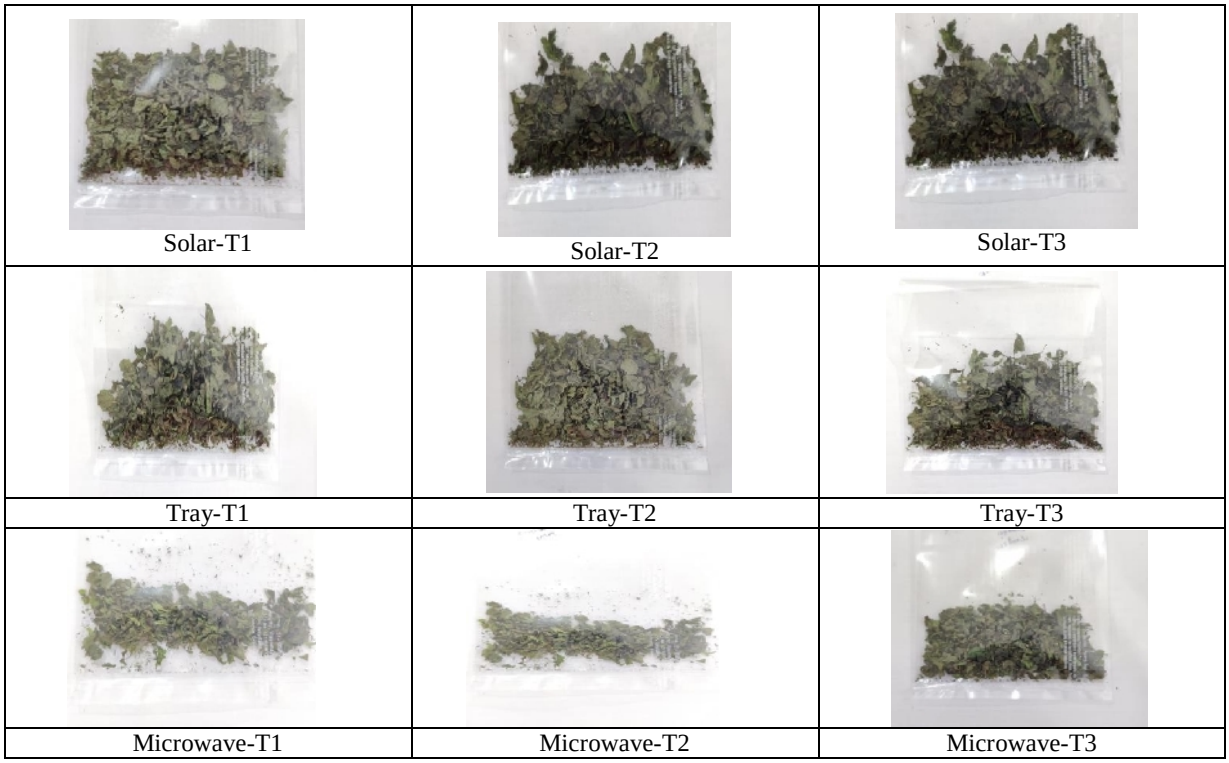

Fig. 8. Dried mint leaves through different treatments with 3 drying techniques.

B. Nutritional composition and microbiology analysis

The proximate composition of mango powder was presented in the Table 3 (Fig. 9). It was observed that moisture content less in tray drying *i.e.*, 2.42 ± 0.04% compared with solar and microwave drying (8.5 ± 0.02 & 9.6 ± 0.05%). The ash content was recorded that highest in tray drying *i.e.*, 2.7 ± 0.01% and low in microwave drying *i.e.*, 1.3 ± 0.04% whereas solar drying is 2.5 ± 0.02%. The fat content in mango powder was observed in tray drying is 2.75 ± 0.05%, solar drying is 2.61 ± 0.04% and microwave drying is 2.04 ± 0.03% and vitamin – C is high in tray drying is 0.07 ± 0.01% compared to solar and microwave drying (0.05 ± 0.01% and 0.02 ± 0.02%). It is concluded that among the entire three drying techniq.ues tray drying found to be best in each parameter. The obtained results are same as results of Zemni *et al.*, (2017).

Table 3: Nutritional composition analysis of mango powder at different drying method.

Sr. No.	Parameters	Tray drying	Solar drying	Microwave drying
1.	Moisture (%)	2.42 ± 0.04	8.5 ± 0.02	9.6 ± 0.05
2.	Ash (%)	2.7 ± 0.01	2.5 ± 0.02	1.3 ± 0.04
3.	Fat (%)	2.75 ± 0.05	2.61 ± 0.04	2.04 ± 0.03
4.	Vitamin-C (%)	0.07 ± 0.01	0.05 ± 0.01	0.02 ± 0.02

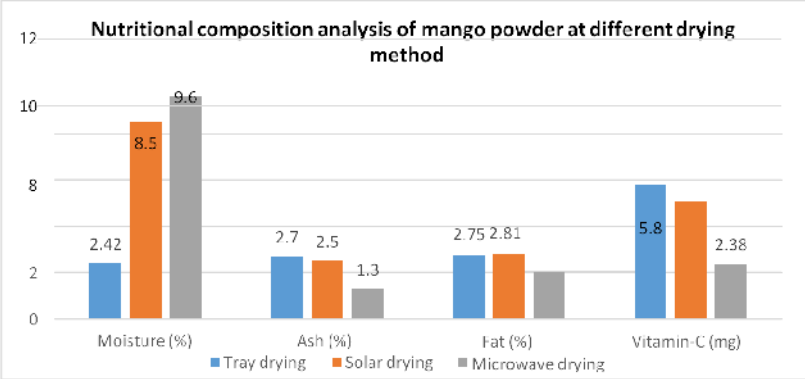

Fig. 9. Proximate composition of mango powder.

The nutritional composition of mint leaves powder was recorded in the Table 4 and Fig. 10. It was showed that moisture content less in tray drying *i.e.*, 3.2 ± 0.05% compared with solar and microwave drying (6.3 ± 0.21% and 8.4 ± 0.01%). The ash content was observed that highest in tray drying *i.e.*, 1.02 ± 0.02 % and low in microwave drying *i.e.*, 0.68 ± 0.04% whereas solar drying is 1.01 ± 0.05%. The fat content in mint leaves powder was observed in tray drying is 0.31 ± 0.05%, solar drying is 0.25 ± 0.01% and microwave drying is 0.15 ± 0.02%. And chlorophyll found tray drying is that 0.0092 ± 0.001%, solar drying is 0.0063 ± 0.003% and microwave drying is 0.0016 ± 0.002%. Carotenoids obtained high in tray drying 0.0162 ± 0.0021% compared with solar and microwave drying (0.0154 ± 0.0022% and 0.0098 ± 0.0034%). It is concluded that among all these proximate analysis, tray drying found to be best in each parameter. The results are comparable with Raviteja *et al*., (2019).

Table 4: Nutritional composition analysis of mint leaves powder at different drying method.

Sr. No.	Parameters	Tray drying	Solar drying	Microwave drying
1.	Moisture (%)	3.2 ± 0.05	6.3 ± 0.21	8.4 ± 0.01
2.	Ash (%)	1.02 ± 0.02	1.01 ± 0.05	0.68 ± 0.04
3.	Fat (%)	0.31 ± 0.05	0.25 ± 0.01	0.15 ± 0.02
4.	Chlorophyll (%)	0.0092 ± 0.001	0.0063 ± 0.003	0.0016 ± 0.002
5.	Carotenoids (%)	0.0162 ± 0.0021	0.0154 ± 0.0022	0.0098 ± 0.0034

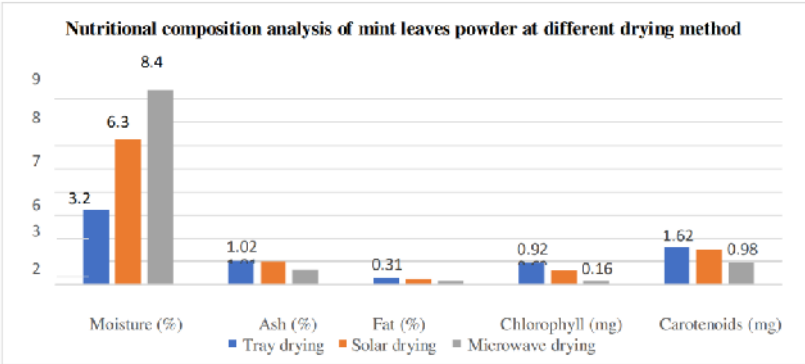

Fig. 10. Proximate composition of mint leaves powder.

C. Microbial analysis

Table 5 represents that, at 10^{-3} dilution in tray dried sample TBC count is 0.55×10^6 cfu, in the microwave dried sample TBC count is 2.5×10^6 cfu at 10^{-3} dilution and solar dried TBC count is 2.63×10^6 cfu at 10^{-3} dilution. Among these dilutions the total highest bacterial count were found in solar drying followed by microwave drying and lowest bacterial count was found in tray drying of mango powder. So it is conformed that tray drying sample is best compared with solar and microwave drying.

In tray dried sample TFC count is 1.1×10^6 cfu, in the microwave dried sample TFC count is 2.1×10^6 cfu at 10^{-3} dilution and solar dried TFC count is 2.82×10^6 cfu at 10^{-3} dilution. Among these dilutions the total highest fungal count were found in solar drying followed by microwave drying and lowest bacterial count was found in tray drying of mango powder. So it is conformed that tray drying sample is best compared with solar and microwave drying Venkanna *et al.,* (2019).

The Table 5 shows that, the test results in all dilution 10^{-3} observed that, total bacterial count is 0.82×10^6 cfu in tray dried sample, microwave dried sample is 1.8×10^6 cfu and solar dried sample is 2.10×10^6 cfu. Among these dilutions the total highest bacterial count were found in solar drying followed by microwave drying and lowest bacterial count was found in tray drying of mint leaves powder. So it is conformed that tray drying sample is best compared with solar and microwave drying. The results are on par with results of Zemni *et al.,* (2017).

The test results in all dilutions of 10^{-3} shows that, total fungal count is 0.98×10^6 cfu in tray dried sample, microwave dried sample is 1.63×10^6 cfu and solar dried sample is 2.91×10^6 cfu. The total highest fungal count were found in solar drying followed by microwave drying and lowest fungal count was found in tray drying of mint leaves powder. So it is conformed that tray drying sample is best compared with solar and microwave drying represented in Table 5.

Table 5: Microbial analysis of mango powder and Mint leaves powder.

Sr. No.	Sample name	Mango slice powder		Mint leaves powder	
		TBC (cfu/g)	TFC (cfu/g)	TBC (cfu/g)	TFC (cfu/g)
1.	Tray drying	0.55×10^6	1.1×10^6	0.82×10^6	0.98×10^6
2.	Microwave drying	2.5×10^6	2.1×10^6	1.8×10^6	1.63×10^6
3.	Solar drying	2.63×10^6	2.82×10^6	2.10×10^6	2.91×10^6

CONCLUSION

- In terms of nutritional information, visual appearance, shelf life studies, the tray drying is found best results in both mango and mint leaves powders fallowed by solar drying technique.
- In microbial study of mango powder the total highest bacterial count were found in solar drying followed by microwave drying and lowest bacterial count was found in tray drying of mango powder. So it is conformed that tray drying sample is best compared with solar and microwavedrying.
- In microbial analysis of mango powder the total highest fungal count were found in solar drying followed by microwave drying and lowest bacterial count was found in tray drying of mango powder. So it is conformed that tray drying sample is best compared with solar and microwavedrying.
- The total highest bacterial count were found in solar drying followed by microwave drying and lowest bacterial count was found in tray drying of mint leaves powder in microbial analysis of mint leaves powder. So based the test results it is conformed that tray drying sample is best compared with solar and microwave drying.
- The test results showed that total highest fungal count were found in solar drying followed by microwave drying and lowest fungal count was found in tray drying of mint leaves powder. So it is conformed that tray drying sample is best compared with solar and microwave drying.
- In case of both mango and mint leaves, the cost of production was less for microwave drying compared two tray and solar drying, it may be due to lesser time required for the microwave drying.
- Though the cost of production of best for microwave drying. The nutritional information, microbial analysis results were best in tray drying. So it is concluded that tray drying technique is suitable for preparation of powders in case of both mango and mint leaves.

FUTURE SCOPE

The research work can continue by drying fruits with Freeze drying technique.

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Conflict of Interest. None.

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