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Research Article

Influenced by Different Drying Methods on Physico-chemical Properties of Dried Mango Slices (cv. Yinkwae mango) (*Mangifera indica* L.)

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Abstract

The experiment was carried out at Department of Food Science and Technology, Yezin Agricultural University (YAU), Nay Pyi Taw from May to August in 2023. It was set up completely randomized design (CRD) with 3 replications to investigate the effect of different drying methods on physico-chemical properties of dried mango slices. Different drying methods of open sun drying, solar tunnel drying and hot air oven drying (at 80 °C for 8 hrs) were set. Partially ripe mangoes were collected at the home garden in Yezin area within the average range of 320g – 350g. The data on initial and final weight of samples, moisture content (% w.b), drying rate (%/hr), weight loss (%), drying time (hours), colour (L*, a* and b*) and browning index (BI) were recorded at every two hours for each treatment. The data on equilibrium moisture content, water activity (aw), weight of final dried products (kg),° Brix, pH, total titratable acidity (TTA%), ascorbic acid content (mg/100g) were recorded for fresh and dried final products. The final moisture content ranged from 20.2 to 21.3% (w.b) depending on drying method. The open sun drying method took the longest drying time of (47 hours) followed by the solar tunnel drying method (46 hours) while hot air oven drying method took (8 hours). From these findings, Yinkwae mango were dried by hot air oven (at 80 °C for 8 hr) had considerably lower in moisture content and water activity with the lowest value of browning index. Moreover, the dried products by hot air oven drying method significantly retained the highest ascorbic acid content among the drying methods. Therefore, the quality of dried mango slices by hot air oven drying method was much better than the quality by open sun and solar tunnel drying methods with respect to less time for drying, low moisture content, less browning index with high ascorbic content.

Keywords: Open Sun Drying; Solar Tunnel Drying; Hot Air Oven Drying; Physico-Chemical; Properties, Color; Yinkwae Mango

Introduction

Mango (*Mangifera indica* L.) belongs to family Anacardiaceae and it is originated in the Indo-Burma region. World mango production is 54.83 million metric tons [1] and three-quarters of production is by the Asian region. The mango is also one of the most popular and important fruits in commercial scale. In Myanmar, the average yield of mango is about 6.83 Mt/ha and the total grown area is 104,000 hectares. The major production areas are Mandalay, Sagaing and Ayeyarwady regions [2]. Moreover, the most prevalent and widely produced mango in Naypyitaw region is found the Yinkwae mango. The postharvest losses of mango have been estimated in the range of 25-40% of the harvested fruit which never get to the consumers and the farm gate because of its spoilage [3,4]. The losses and waste of Yinkwae mango may also occur more than 50 % at harvest season in many home gardens. There is still no sustainable and systematic market for Yinkwae mango in glut season. Therefore, value-added products from Yinkwae mango should be developed by food processing like drying, freezing and making juice and pulp. Among the processing methods, drying is mostly and widely used in food industry to reduce product deterioration and to provide microbiological stability and to extent the storage life [5]. The selection of a suitable drying technology is a challenging task and-traditional drying method is low cost and low energy value. The temperature and duration time will greatly effect on the quality of the products such as color, nutrient contents of Vitamin C and A due to different drying methods. Food processing will be effective to develop value added product by reducing food waste, increasing farmer's income and creating job opportunities. Therefore, this study was aimed to investigate the effect of different drying methods on the drying characteristic and physico-chemical properties of dried mango slices.

Materials and Methods

The experiment was conducted at the Department of Food Science and Technology, Yezin Agricultural University (YAU) in May to December 2023. Partially ripe Yinkwae mangoes were collected at the home garden in Yezin area within the range of 320g – 350g in weight. Mangoes were cut into slices of (6-7 cm) in length with a thickness of (1-2 cm) and then they were soaked for 1 hour in lime water. The mango slices were steamed for 15 minutes and then 15% of sugar was added for every treatment. The experiment was allocated with a completely randomized design (CRD) with 3 replications. A total of 72 kg of sliced fresh pulp of Yinkwae mangoes were dried by different drying methods of open sun drying (at 25-35°C), solar tunnel drying (at 29-39°C) and hot air oven drying (at 80°C for 8 hr). The drying processes were done to reach the water activity of 0.64 and the dried final products were recorded for every treatment.

Data collection

The data on initial and final weight of samples, moisture content (% w.b), drying rate (%/ hr), weight loss (%), drying time (hours), colour and browning index (BI) were recorded at every two hours for each treatment. The data on equilibrium moisture content, water activity (aw), weight of final dried products (kg),˚**Brix**, pH, total titratable acidity (TTA%), ascorbic acid content (mg/100g) were recorded for fresh and dried final products.

The value of colour (L*, a* and b*) of the fresh and dried mangoes were measured by a colorimeter Minolta NR-20XE. The juice sample was prepared by grinding the dried mango samples and the total soluble solids˚Brix was determined by hand-held digital pocket refractometer (Atago 3810 PAL-1). For total titratable acidity (TTA%), the 10 ml of fruit juice was taken into a conical flask was titrated against alkali such as 0.1N NaOH solution along with 1-2 drops of phenolphthalein indicator according to [6] method. The pH of dried mango slices was measured using a laboratory pH Meter (PHOENIX Instrument, EC-45). Ascorbic acid content was determined by using the 2, 6-dichloro-indophenol titration as per the procedure described by [7,8]. All collected data were statistically analyzed by using Excel program and Statistix version 8. The treatment means were compared by using Least Significant Difference (LSD) at 5% level.

Results and Discussion

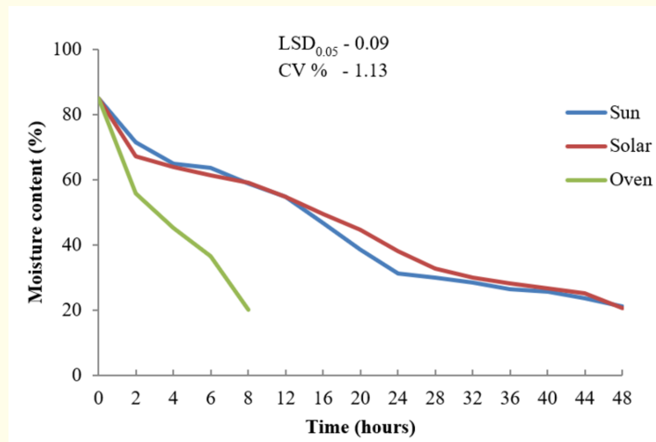

Figure 1: Effect of different drying methods on moisture content (%) of dried mango slices.

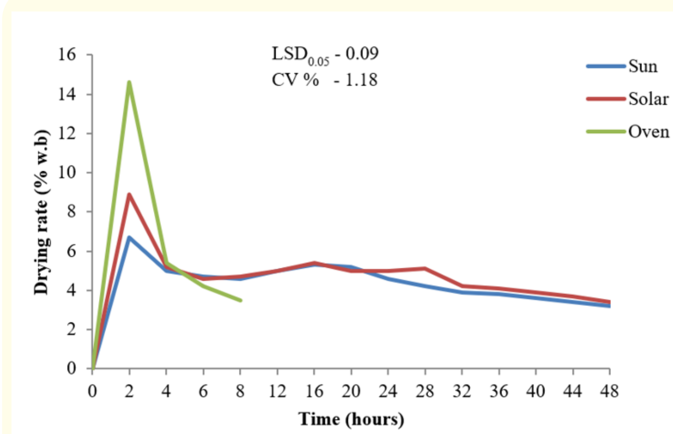

Figure 2: Effect of different drying methods on drying rate (% w.b) of dried mango slices.

Effect of different drying methods on moisture content (%) of dried mango slices

Figure 1 shows the initial moisture content of fresh mango slices was 85% and the final moisture content of dried mango slices ranged from 20.2% (w.b) to 21.3% (w.b) according to the drying methods. During the drying process, different drying methods have different drying time and characteristics respective to reach the final equilibrium moisture content. In the open sun drying method, moisture content gradually decreased and it took 47 hours followed by the drying method of solar tunnel showing 46 hours to reach the final equilibrium moisture content.

In hot air oven drying method, the moisture content rapidly decreased and it took only 8 hours at 80°C to reach the final equilibrium moisture content. Thus, the highest moisture content and longer drying period was observed in open sun drying followed by solar tunnel drying while it was the lowest in hot air oven drying. This may be due to the maintained high temperature inside the hot air oven, which can favor more water loss and short time for drying for fresh Yinkwae mango slices.

Effect of different drying methods on drying rate (% w.b) of dried mango slices

In all drying methods, the drying rate was higher at the beginning of drying process and it gradually decreased during the drying process due to less moisture content in the dried products. This finding was similar to Gupta., *et al*., (2018) [9] who found that the rate was higher in the beginning of the drying process and then gradually decreased later part of the drying process. Figure 3.2 shows the effect of different drying methods on drying rate (% w.b) of dried mango slices. According to the figure, the drying rate of mango slices inside the oven was found to be higher than that of the open sun-dried samples and solar tunnel-dried samples.

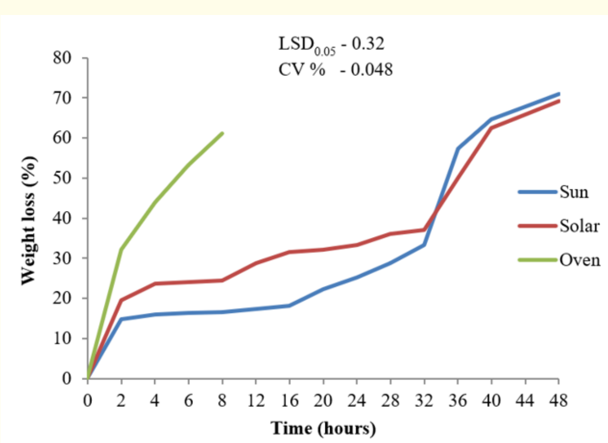

Figure 3: Effect of different drying methods on weight loss (%) of dried mango slices.

Effect of different drying methods on weight loss (%) of dried mango slices

Data presented in Figure 3.3 reveals the effect of different drying methods on weight loss (%) of dried mango slices. The highest weight loss 71% was found in the open sun drying method and followed by solar tunnel drying 69.3% while the lowest weight loss 61.1% was found in the hot air oven drying method. It was found that the higher the weight loss %, the lesser the weight (kg) of the remaining final dried products.

No.	Treatments	Drying time (hr)	Water activity(aw)	Weight of final dried product (kg)
1.	Open sun drying	47	0.645	7.83
2.	Solar tunnel drying	46	0.643	8.3
3.	Hot air oven drying (at 80 °C for 8 hr)	8	0.625	10.5

Table 1: Effect of different drying methods on drying time (hr), water activity (aw) and weight of final dried products (kg) of dried mango slices.

Effect of different drying methods on drying time (hr), water activity (aw) and weight of final dried products (kg) of dried mango slices

Table 3.1 shows the effect of different drying methods on the drying time (hr), water activity (aw) and weight of final dried products (kg) of dried mango slices. For drying time, the open sun drying method took 47 hours followed by 46 hours in the solar tunnel drying method. The respective corresponding average temperatures were 25-35 ºC and 29-39 ºC for open sun and solar tunnel drying methods with the same relative humidity of 50 to 55% for both conditions. The temperature in the solar tunnel was 4 ºC higher than that of open sun drying due to high temperature inside the solar tunnel dryer. The hot air oven drying method took 8 hours only for drying. It was found that the oven drying method was the lesser time than others due to the stability of heat inside the oven by removing water, moisture and other solvents from the product. The benefit of using oven is having a fan or turbine which sparks the convection process that heats and dries the materials inside. It is also economical and safe for food products.

There were no differences in values of water activity with the regardless of drying methods. The highest water activity value (0.645) was found in the open sun drying method followed by

(0.643) by the solar tunnel drying method. However, the hot air oven drying method had the lowest water activity value of (0.625).

The initial weight of fresh mango slices was (27) kg for each drying method, respectively. It was found that open sun drying method remained the lowest final dried products of 7.83 kg while solar tunnel drying method remained 8.3 kg. However, the hot air oven drying method remained the highest weight in final dried mango products of (10.5) kg.

Effect of different drying methods on° Brix, pH, Total Titratable Acidity (TTA% and ascorbic acid content (mg/100g) of fresh and dried mango slices

Data presented in table 3.2 reveals the effect of different drying methods on °Brix, pH, TTA (%) and ascorbic acid content (mg/100g) of fresh and dried mango slices.

The° Brix, pH and TTA% of dried mango slices were not significantly different from one another. According to this study, the dried mango slices had pH of 4.5, TTA% of 0.15, and° Brix of 3.4%. This study was similar to Anon (1962) [10] who found that the pH value of dried mango was ranged from 3.4-4.8. According to Mwanzia., *et al*., (2022) [11] found that TTA of dried mango slices ranged from 0.15 to 0.69%.

The hot air oven-dried mango slices showed significantly the highest ascorbic acid content (35.5 mg/100g) compared to solar tunnel dried samples (16.2 mg/100g) and open sun dried samples (15.7 mg/100g) respectively. The longer the drying time, the lesser the ascorbic acid content in food products [12]. Therefore, open sun and solar tunnel drying methods showed lower ascorbic acid content than oven drying methods. The loss of ascorbic acid during the drying process was mainly influenced by temperature and duration time. It may be recorded that the higher temperature with a shorter time was efficient for the product by minimizing the losses of ascorbic acid.

Effect of different drying methods on L* (lightness), a* (redness), b* (yellowness) and Browning index (BI) values of fresh and dried mango slices

Data presented in table 3.3 reveals the effect of different drying methods on L* (lightness), a* (redness), b* (yellowness) and browning index (BI) values of fresh and dried mango slices. The dried mango samples were highly significant differences among the drying methods. The highest L*, a* and b* values were found in open sun drying method followed by solar tunnel drying method and hot air oven drying method. However, the browning index of open sun drying was the highest value. The browning index is a measure of the extent of browning in food products due to enzymatic or non-enzymatic reactions. Hot air oven-dried samples were significantly lowest in browning index (15.39) while the browning index value of solar and open sun drying were 22.31 and 25.85 respectively. Demircan., *et al*. (2024) [13] reported that a higher browning index indicates a greater degree of browning, which can lead to a decrease in the quality of food products. Based on the results, dried mango slices by hot air oven drying method may be a commercial method with better color quality and the highest ascorbic acid content.

Conclusion

In different drying methods, open sun drying took 47 hours to reach the final equilibrium moisture content followed by 46 hours of solar tunnel drying method while the hot air oven drying method took only 8 hours. There were no significant differences in° Brix, pH, TTA (%) in all drying methods. The best color with the least browning index value and the highest ascorbic acid content were observed in the hot air oven drying method. Based on the results, hot air oven drying was the most efficient method for drying of mango slices which showed not only considerably low moisture content and water activity but also the highest drying rate and the least value of browning index with the highest ascorbic acid content. Moreover, the hot air oven drying method remained the largest final dried product than other drying methods. Therefore, it can be revealed that hot air oven drying method is beneficial for commercial drying and it also maintains the quality of food products.

Acknowledgments

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