Original Article

A Comparative Analysis of Cutting Force on Novel Tray Dried Muskmelon (Cucumis Melo) with Oven Dry Method

Ch. Narmada[1], Siva Shankar. V[2]

[1]Research Scholar, Department of Agricultural Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India. Pin Code: 602105.
[2]Project Guide, Corresponding Author, Department of Agricultural Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India. Pin Code: 602105.

Abstract

Aim: The goal of this study is to evaluate the cutting force and texture of muskmelon samples using the oven and tray drying method. **Materials And Methods:** Group 1 (N=20) is assigned to Tray drying, while group 2 (N=20) is assigned to oven drying in this experiment. Samples of muskmelon fruits were dried in the tray and oven drier for 5, 6, and 7 hours at 40°C, 50°C, and 60°C with dimensions of 1 cm^3, 8 cm^3, 27 cm^3 respectively. On dried materials, the cutting force (N) was evaluated using the texture analyser. The significant value was obtained at a $p<0.05$ level using SPSS v.26 software. **Results:** When comparing the tray dry method (108 N) to the oven dry method (106 N), the oven dry method had a greater mean value of cutting force, but the tray dryer retained texture and quality. The cutting force measured from the tray and oven dried processes indicated a significant difference with a p=<0.01 ($p<0.05$) which is statistically significant. The size for each gathering was determined by utilizing past concentrate on outcome in clinical.com by keeping G power as 80%, edge 0.05 and certainty span as 95%. **Conclusion:** According to the findings, muskmelon dried at 40°C in an oven dryer has greater cutting force than muskmelon dried in a colour dryer, but tray dryer maintains adequate texture, quality, and colour, therefore tray dryer is deemed superior to the oven dryer.

Keywords: Cutting Force, Novel Drying Method, Muskmelon, Tray Drying, Oven Drying, Moisture Content.

DOI: 10.47750/pnr.2022.13.S04.076

INTRODUCTION

The major goal of this study is to extend the shelf life of muskmelon by drying muskmelon and analysing the quality or texture by measuring the cutting force. Muskmelon (*Cucumis melo*) is a cucurbit that helps with digestion and immune system strength. The Cucurbitaceae family, which includes cucurbits, is a group of fruit-producing plants with a wide range of therapeutic properties (Dhiman et al. 2012). In the 2018-19 season, India produced 1231 MT of muskmelon on 54 hectares of land. The states of Uttar Pradesh, Andhra Pradesh, Madhya Pradesh, Punjab, and Haryana produce the most muskmelon in India. China is the world's leading producer, followed by Turkey, Iran, and India. Muskmelon can be kept at room temperature for two days or refrigerated for three to five days. It has a high commercial value, but due to its short shelf life, it is prone to quality and quantity degradation. It also causes a loss of flavour and a rise in infection rates. Due to current commercial handling practices, a considerable loss of marketability occurs within two weeks of harvest. Muskmelon quality was affected by temperature variations during storage (*Cucumis melo* L). Weight loss was about 2.9 and 3.4 times higher in the 4°C and 10°C samples, respectively (Youn et al. 2009). Muskmelon post-harvest losses average 22-30% each year; drying is done to prevent these losses (Yahaya and Mardiyya 2019). The effects of storage conditions (temperature, humidity, and time) on fruit quality and mechanical qualities are significant (Ekrami-Rad, Khazaei, and Khoshtaghaza 2011). This is due to the fact that reduced moisture content inhibits bacteria growth, allowing food to survive longer. On a big scale, the drying method is the most effective technique to keep solid meals safe for a long period. To ensure product quality, this operation must be meticulously regulated and optimised. Food drying lowers the water activity of the food, extending its shelf life and preventing spoiling. This preserves product quality, reducing losses and making them available during times of scarcity, off-season use, and for locations far from the producing site (Santos and Silva 2008). Fruit mechanical properties are important qualities in terms of quality and must be evaluated scientifically. Firmness can be used to track the progression of maturity during storage, assisting in the selection of the ideal storage conditions for fruits with a long shelf life (Sousa et al. 2003). Change in texture is determined by the firmness or the cutting force. Cutting force can be used to assess maintaining quality, ripening, resistance to harm during handling, and cultivar differences. Fruit and vegetable firmness, or texture, is a significant quality feature. However, the cutting force of the product also indicates its storability and resistance to harm. For many fruits and vegetables, firmness is a good indicator of ripeness (Lana, Tijskens, and van Kooten 2005). The texture of food is primarily concerned with describing the structure of the food and how that structure reacts to applied force (Lin, D. Durance, and Scaman 1998).

Over the last 5 years, there have been 147 publications published in Google Scholar and 160 in PubMed relating to this subject. Pungency, colour, texture, and rehydration ratio of garlic slices were evaluated using various novel drying methods by (Cui, Xu, and Sun 2003). The whole fruit cutting energy and power, maximum cutting force, peel shear strength and strain, and shear modulus all increased with storage time, according to (Ekrami-Rad, Khazaei, and Khoshtaghaza 2011) research. Experiments were carried out by nandu to determine the effects of cutting force. Experiments were carried out by (Liu, Liang, and Guo 2012) to determine the effects of cutting force. (Arumuganathan and Manikantan 2010) determined the cutting force and energy of several dried mushrooms. The best study related to this article is (Alam and Gupta 2014), cutting force and cutting energy were determined for various novel drying methods and tray drying kept more quality and texture than other varieties.

Our team has extensive knowledge and research experience that has translate into high quality publications(Bhansali et al. 2021; Jayanth et al. 2021; Sudhakar, Ravel, and Perumal 2021; Sathiyamoorthi et al. 2021; Deepanraj et al. 2021; Raju et al. 2021; Arun Prakash et al. 2020; Kamath et al. 2020; Shanmugam et al. 2021; Rajasekaran et al. 2020; Adhinarayanan et al. 2020; Rajesh et al. 2020; Aurtherson et al. 2021)(Bhansali et al. 2021; Jayanth et al. 2021; Sudhakar et al. 2021; Sathiyamoorthi et al. 2021; Deepanraj et al. 2021; Raju et al. 2021; Arun Prakash et al. 2020; Kamath et al. 2020; Shanmugam et al. 2021; Rajasekaran et al. 2020; Adhinarayanan et al. 2020; Rajesh et al. 2020; Aurtherson et al. 2021). Based on the previous research, the objective of this study is to test the cutting force of the muskmelon samples and compare between the two types of dryers i.e tray dryer and oven dryer.

MATERIALS AND METHODS

The research was done at the Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences in Chennai, Tamil Nadu. The size for each gathering was determined by utilizing past concentrate on outcome in sample test calculator by keeping G power as 80%, edge 0.05 and certainty span as 95% (Lektemur Alpan and Torumtay Cin 2020)(Button et al. 2013)(Lektemur Alpan and Torumtay Cin 2020). Two types of drying techniques were utilised to analyse muskmelon samples: tray drying (group 1) and oven drying (group 2) at temperatures of 40°C, 50°C, 60°C and the dimensions of 1 cm^3 (1 cm x 1 cm x 1 cm), 8 cm^3 (2 cm x 2 cm x 2 cm), 27 cm^3 (3 cm x 3 cm x 3 cm) and time of 5 hrs, 6 hrs, 7hrs. The sample size of each group is 20 and the total sample is 40. Muskmelon was bought from the local market. The samples that were infected, damaged, or bruised were manually isolated. Seeds were physically taken from healthy, evenly formed samples, which were then cleaned, peeled, and cut into little, dimensioned pieces measured using vernier caliper. The next step is blanching. Blanching involves scalding them briefly in boiling water and then rinsing them in cold water. It also improves the product's quality by eliminating particles from the surface.

Tray drying of the muskmelon cubes that were put in thin layers on the trays once the dryer was pre-heated to the suitable temperature. A control panel, an electric supply, and an air heating system with six 60 cm x 40 cm x 2 cm trays set at 5 cm intervals make up the tray drier. Following the start of the novel drying methods, weights of the sample were taken every hour on an analytical weighing scale until a steady weight was reached. At three distinct temperatures of 40°C, 50°C, and 60°C with the dimensions of 1 cm^3, 8 cm^3, 27 cm^3 and time of 5 hrs, 6 hrs, 7 hrs (Pragati and Preeti 2014).

Oven drying of the muskmelon cubes were arranged in single layers on the trays of the oven drier (Lawerance & Mayo STXL095), which comprises of a control panel, electrical supply, and a drying chamber with two trays with dimensions of 45 cm x 45 cm x 45 cm. An analytical weighing balance was used to weigh the sample every hour until it attained a steady weight. The approach included taking samples at three distinct temperatures: 40°C, 50°C, and 60°C and dimensions of 1 cm^3, 8 cm^3, 27 cm^3 for a time period of 5 hrs, 6 hrs, 7 hrs (Kamiloglu et al. 2016). The oven drying was done in the soil mechanics lab, whereas the food engineering lab did the tray drying. The weight loss of the sample was measured using a WENSAR analytical balance. A timer was used to record the time it took for the sample to dry, and the moisture content was used to compute the drying time.

As shown in Table 1, some samples were dried in the oven, while others were dried on a tray dryer in various combinations of treatments. The cutting force of the dried muskmelon sample was determined using a texture analyser's cutting test. To conduct this test, a knife measuring 0.062 metres in length, 0.024 metres in breadth, and 0.0005 metres in thickness was pushed into a slot in a metal table. The cutting was done at a speed of 0.001 m/s and the load cell was set to 250 N. When the sample resisted, the cutting began and continued until the intersection was complete. For the muskmelon samples, the maximum cutting force and cutting energy were recorded using the programme "Texture" and then calculated. Finally, a comparison was made between the two drying techniques to see which has more cutting force and high quality retention.

Statistical analysis

By comparing tray drying to oven drying, SPSS v.26 was used to find significance. An independent sample T-test is used in the analysis, with novel drying methods, temperature, thickness, and duration as independent variables and fat content as the dependent variable (Poornima et al. 2019)**.**

RESULTS

The cutting force increased as the drying temperature increased. The cutting force changed as the thickness of the sample varied. The drying temperature and sample thickness have a substantial effect on cutting force, according to the analysis of variance. The minimum and maximum cutting force required for a dried muskmelon is 74 N and 109 N. The cutting force of the muskmelon samples following treatment is shown in Table 1. The cutting force comparison between the novel drying methods at treatment combination is shown in Figure 1. Figures 2 and 3 represent the oven and tray dried muskmelon samples at various parameters. Treatment 3 is thought to be the most effective at preserving the quality and texture of the muskmelon sample. Table 2 shows the repetition of samples for cutting force at treatment T3. The cutting force of the muskmelon sample at the combination of treatment 3 (T3) is 109 N and 106 N for the oven and tray dryer respectively. It is obvious that the cutting force in the oven dryer is more than the tray dryer which is helpful to maintain the better quality. Treatment (T3) has temperature of 60℃ and time of 7 hrs with less thickness of dimensions 1cm^3 leads to maximum cutting force of 109N and 106N for oven dryer and tray dryer respectively whereas treatment (T7) has less temperature of 40℃ and time of 7hrs with more thickness of dimension 27 cm^3 has the minimum cutting force of 76N and 74N for oven and tray dryer correspondingly. Even though the oven dryer has a higher cutting force, the tray dryer maintains quality and texture better, hence the tray dryer is preferred over the oven dryer. Table 3 exhibits the cutting force group statistics and Table 4 shows the independent sample T-test. The mean cutting force of the oven dryer is 108.7000, which is higher than the 105.9000 of the tray dryer. For tray dried and oven dried samples, the standard deviation and standard error are 0.23056, 0.12354 and 1.03110, 0.55251 respectively. The tray dryer keeps greater quality than the oven dryer in terms of statistical significance.

DISCUSSION

Even though the cutting force is maximum for the oven dryer compared to the tray dryer, retention of quality and texture is better in the tray. The difference between the percent of the cutting force between the tray drying method and the oven drying method is 3%. Because at 60℃ the sample state is not edible due to the over burning of the muskmelon. So the optimum temperature and dryer for the cutting force is 50℃ as moisture content is maintained for safe storage level and tray dryer respectively. Increase in thickness leads to degradation of cutting force, so the samples with dimensions 27 cm^3 have minimum cutting force and samples with dimensions of 1cm^3 have the maximum cutting force. Increase in temperature leads to improvement of cutting force, so the samples at high temperature have the maximum cutting force. Cutting force is extremely significant, with value $p<0.05$ significance threshold. The tray dryer retains more quality and hardness than the oven drier, despite the fact that the oven dryer has a higher cutting force, as seen in Figure 1.

Similar results were observed by the (S. Singh, Riar, and Saxena 2013) where they mentioned cutting force depends on the thickness and temperature. According to them, at the minimum temperature of 55℃ the respective cutting force was 108.7 N with thickness of 3mm and at the maximum temperature of 75℃ the cutting force was 193.2 N with thickness of 3mm. (Hatamipour et al. 2007) reported that the quality and texture of sweet potato was maintained by tray dryer rather than the oven dryer. (Prachayawarakorn et al. 2008) also reported the similar result that indicates an increase in the drying temperature leads to change in the texture of the food product. (K. K. Singh and Reddy 2006). A study by (Dowgiallo 2005) indicated that nutritional compounds were more sensitive to drying temperature than drying time, whereas ascorbic acid was easily destroyed by a long drying time. The results of (Arinola, Ogunbusola, and Adebayo 2016)were opposite to the findings of this research as they concluded that oven dried samples maintained better quality and texture compared to the tray dried samples.

The limitation to the study is increase in temperature and cutting force enhance the loss of colour, texture, and nutritional value, so choose the best temperature and dryer to keep the nutritional content, colour, firmness, and quality. As a result, this research can be expanded with more advanced types of dryers, such as the freeze dryer, which saves time, labour, and works more effectively than other traditional dryers with ease of loading and helps to maintain product quality.

CONCLUSION

Tray drying was found to be an effective novel drying method for determining cutting force in the muskmelon samples as compared with the oven dryer. Even though the oven dryer has the maximum values of cutting force, retention of colour, texture,nutrients and quality is less. It can be concluded that cutting force is influenced by the thickness and drying temperature of the muskmelon sample. The optimum quality and texture muskmelon product for cutting force was discovered at 50°C for a thickness of 1 cm^3. Tray dryer is best compared to oven dryer regarding cutting force as a reason for better quality and texture with more retention of nutritional components. cutting force is highly significant with the value <0.001 ($p<0.05$).

Declarations

Conflict of Interest:

The authors of this paper declare no conflict of interest.

Authors contribution

Author CHN was involved in data collection, data analysis & manuscript writing. The author guide SSV was involved in conceptualization, data validation, and critical review of manuscripts.

Acknowledgment

The authors would like to express their gratitude towards Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences (Formerly known as Saveetha University) for giving the necessary infrastructure to carry out this work successfully.

Fundings: We thank the following organization for providing financial support that enabled us to complete the study.

1. VPR Mining Infrastructure PVT.LTD
2. Saveetha University.
3. Saveetha Institute of Medical and Technical Sciences.
4. Saveetha School of Engineering.

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TABLES AND FIGURES

Table 1. The orthogonal array for the cutting force (N) present in the oven and tray drying process at the various parameters such as temperature, dimensions and time.

Treatments	Dimensions (cm^3)	Temperature (℃)	Time (hr)	Cutting force (N) in Tray drying method	Cutting force (N) in Oven drying method
T1	1	40	5	89	91
T2	1	50	6	98	99
T3	1	60	7	106	109
T4	8	40	6	83	85

T5	8	50	7	90	93
T6	8	60	5	100	102
T7	27	40	7	74	76
T8	27	50	5	82	83
T9	27	60	6	91	94

Table 2. The effect of novel drying methods on the cutting force of muskmelon samples at the combination of Treatment 3 (60℃, 7 hrs, 1cm^3).

Sample No	Tray drying method Cutting force (N)	Oven drying method Cutting force(N)
1	106	108
2	105	110
3	106	109
4	106	110
5	106	108
6	105	110
7	107	109
8	106	108
9	106	108
10	106	107
11	106	108
12	105	110
13	106	109
14	106	110
15	106	108
16	105	110
17	107	109
18	106	108
19	106	108
20	106	107

Table 3. Statistical analysis of mean, standard deviation and standard error of novel drying methods for cutting force. There is a statistical significant difference between the groups. tray dry has a higher mean than oven dry.

Group Statistics					
	Groups	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Cutting force	Tray drying method	20	105.9000	0.55251	0.12354
	Oven drying method	20	108.7000	1.03110	0.23056

Table 4. Comparison of significance level for cutting force with value of $p<0.05$. cutting force has significance levels less than 0.05

Independent Samples Test											
		Levene's Test for Equality of Variances		**t-test for Equality of Means**						**95% Confidence Interval of the Difference**	
		F	**Sig**	**t**	**df**	**One-sided p**	**Two-sided p**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
Cutting Force	**Equal variances assumed**	15.373	<.001	10.70	38	<.001	<.001	2.80	0.261	2.2704	3.329
	Equal variances not assumed			10.70	29.08	<.001	<.001	2.80	0.261	2.2650	3.334

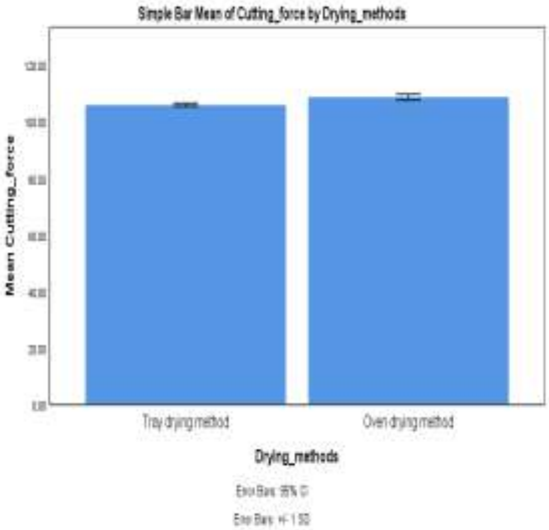

Fig. 1. Box Plot graphical representation of the mean cutting force of muskmelon and Novel drying methods. The mean cutting force of tray dryer appears to be better than oven dryer and the standard deviation of tray dry appears to be better than oven dry . X Axis: Tray dry vs Oven dry method Y Axis: Mean cutting force +/- 1 SD.

Fig. 2. Samples of muskmelon fruit placed in a dryer for the treatment (a) Tray dryer (b) Oven dryer.

Fig. 3. The tray (T) and oven (O) dried muskmelon samples at the temperature of 40°C , 50°C , 60°C for 5 hrs, 6 hrs, 7 hrs.