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Characteristics of Dried Grapes by Different Drying Methods

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Abstract:- Grape is one of the most important fruit crop in the world due to its nutritional and therapeutic value. Grapes are good source of dietary sugars, organic acids and some vitamins. The seedless raisins are called as Kishmish. Raisin not only provides sweetness but also is excellent source of dietary fibres, some amount of minerals and vitamins. The study on making grape raisins was carried by. Open drying (Sun drying) is widely used due to its low initial and running costs but depend mainly on weather conditions, which can induce microbial and insect contamination and hence, lower their quality. Drying rate and drying time was faster in tray drying compare to others three drying methods but the disadvantage of tray drying was it is batch process and cannot be used for mass production and the consumption of power is more. The quality of raisins from sensory evaluation were highly accepted in controlled shade drying where temperature and humidity is maintain as per the requirement and least accepted in open drying. Controlled shade drying is better drying method compare to other methods as it is a continuous process and less chances of contamination and high quality of product is obtained. The mean score for colour/appearance, texture, taste, flavour and acceptability of the raisins prepared by different drying methods ranged from 6.1 to 8.4, 6.3 to 8.1, 6.2 to 8.3, 6.3 to 8.0 and 6.2 to 8.3 respectively.

Keywords:- *Grapes, Raisins, Shade Drying, Controlled Shade Drying, Tray Drying, Sensory Evaluation.*

I. INTRODUCTION

Farming is the most significant segment of the Indian economy from the point of view of neediness easing and business age. While half of our populace still reliant on horticulture for the vast majority of their livelihoods, we can't expect comprehensive development in the event that we don't revive our farming. India's near favorable position in horticulture doesn't lie in land concentrated harvests yet in the process of giving birth escalated high worth yields like natural products, vegetables and naturally delivered fibers.

Globalization of world trade has opened up tremendous open entryways for multifold increase in passage of Indian things. Agribusiness, which shapes over 33% of the money related activity, of the country, doubtlessly stays in a resultant piece of elbowroom for tapping this potential in the field of cultivation is an aftereffect of the fluctuating climatic conditions and formation of an arrangement of vegetables and regular items with yearly production of 1.88 million tons from 79.6 thousands hectares of land. Grape is a natural product, organically a berry, of the deciduous woody vines of the blooming plant family Vitis. Grapes are developed since ancient occasions. The worldwide grape creation right now adds up to more than 75.8 million tons (Mt) as indicated by Food and Agriculture Organization and International Organization of Vine and Wine (OIV) information for 2016. The world's five biggest grape makers are: China (about 14.5 Mt), Italy (about 7.9 Mt), United States of America (about 7.1 Mt), France (about 6.4 Mt) and Spain (about 6.0 Mt). Around 71% of this creation is bound for wine making, while the rest of expended new as table grapes and squeeze or dried as raisins (Zemni et al. 2017).

Grape is a significant business organic product yield of India, which adds to the greatest offer among the new foods grown from the ground sent out to Europe and different pieces of the world. As per the gauge of NHB, the absolute zone and creation of grapes in the year 2016-17 was 136.0 thousand hectares and 2.6833 million tons, separately. Significant grape developing states are Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu and the North-Western area covering Punjab, Haryana, western Uttar Pradesh, Rajasthan and Madhya Pradesh. In India, raisins are principally delivered in Sangli, Solapur and Nasik locale of Maharashtra and Vijayapur area of Karnataka state (Venkatram, 2017).

Because of their high dampness and sugar substance, grapes are truly short-lived, regardless of whether put away under the best refrigerated conditions, they despite everything remain profoundly vulnerable to defilement with waste by pathogenic microorganisms. That is the reason these organic products ought to be expended new or changed over to other determined items inside barely any weeks after collect in any case, their attractiveness would be endangered, which could bring about prominent monetary misfortunes (Bhat et al. 2012). The improvement of grape the board, handling and promoting is required which, thus, underlines the requirement for the selection of progressively effective saving methodologies. In this regard, drying, as the most established food-safeguarding strategy, ought to be one of methods that may fulfill this need by improving inferred grapes item

quality, broadening their accessibility and differentiating their exchange (Zemni et al. 2017).

Drying fundamentally evacuates the overabundance of water until a fitting dampness level is arrived at that hinders the development of microorganisms, molds, and yeasts, hinders the chemical corruption and inactivates most of the physical and biochemical responses (Araya and Ratti, 2008). It is accepted that the first raisins were created in the close to east by just covering the grapes in the sand. The point of grape drying was to expand their timeframe of realistic usability and, because of their high sugar content, to give phenomenal wellsprings of vitality to laborers executing hard undertakings (Carughi et al. 2008).Preserving grapes as raisins has different points of interest including decrease of weight and mass, which add to the reducing of pressing, stockpiling and transportation costs, too (Wang et al. 2016).

World creation of dried grapes (Raisins, Sultanas and Currants) arrived at 1.24 million tons during 2016–2017. Turkey was the significant maker, representing 310,000 tons (25%), trailed by the US with 297,738 tons (24%), China with 185,000 tons (15%) and Iran with 170,000 tons (14%).The four nations together record for 78% of the world creation, as indicated by the most recent report of the United States Department of Agriculture (USDA) 2016.

Usually, dried grapes are utilized as a fixing in heating, snacks, breakfast grains and candy store industry (USDA). In 2016, about 1.2 million tons of raisins were expended on the planet, an expansion of 17% from 2000. Within excess of 250,000 tons devoured, the United States and Turkey are the main household markets, representing 25% of worldwide utilization. China, with 203,100 tons of dried grape expended in 2016, was in third spot (FAO-OIV). World raisin utilization is in certainty is consistently expanding because of its wholesome quality perceived by customers (USDA).

Sun and sun based drying are the two techniques customarily utilized for drying of business raisins. Be that as it may, these procedures are exceptionally slow and rely for the most part upon climate conditions, which can instigate microbial and creepy crawly pollution of the subsequent dried leafy foods, bring down their quality (Pangavhane and Sawhney, 2002). All the more as of late, progressed drying methods, for example, stove drying, microwave drying, vacuum beat drying, infrared drying and numerous others have been utilized so as to upgrade the lack of hydration rate and assurance a superior nature of the raisins (Wang et al. 2016). Normal drying of grapes incorporates the open sun drying (with or without spread) and shade drying (Pangavhane and Sawhney, 2002). As a conventional technique, characteristic drying of grape can be dated to 1490 BC in Greece and even today it is still generally applied, particularly in creating nations because of its low introductory and running expenses (Jairaj et al. 2009; Esmaiili et al. 2007).

The primary reason for tactile assessment is to decide the food quality attributes and the level of consistence with the legitimate prerequisites and buyer propensities. The first and most basic boundary of food is the tangible qualities. It is mind boggling property, and it is a sentiment about the item itself, which can't be supplanted by some other strategy. The shading, taste, and surface (for example organoleptic characteristics) of the raisins created are significant properties for customer acknowledgment and are decided by tangible assessment (Ranganna, 1977). The nature of item may decay during capacity because of impact of different medicines and handling techniques and furthermore due to physico-synthetic changes in the item as affected by capacity condition.

II. MATERIAL AND METHODS

The present experiment on **"Study on drying characteristics of grape raisins by using different drying methods"** was carried out at two locations simultaneously in MIT College of Food Technology and ICAR- National Research Centre for Grapes, Manjiri Farm, P B No 3, Solapur Road,

❖ *Details of Experiment*

1. Location- MIT College of Food Technology and ICAR-National Research Centre for Grapes, Loni Kalbhor, Pune.
2. Year and season of experiment- Summer 2019
3. Name of crop- Grape (*Vitis vinifera* L.)
4. Variety- Thompson seedless
5. No. of drying methods- 4
6. Total weight of grapes- 100 kg
7. Weight of grapes/drying methods- 6.25 kg

❖ *Preparation of sample*

A. Sample selection

Variety: Fresh Thompson seedless grapes will be used due to its good variety.
Moisture content: The moisture content of Thompson seedless grapes is between 75 to 85%.
Availability: February to May

B. Procurement of grapes

All cracked, diseased, malformed and discoloured berries were sorted out and discarded. The berries were washed with water for removal of adhering dust and foreign matter. The average diameter, total soluble solids, skin thickness, moisture content, acidity, pH were determined from the fresh grapes.

C. Preparation of dipping solution

Grapes were taken and were placed in 20kg plastic carat. Dipping solutions were prepared in water by dissolving ethyl oleate (1 liter) and Potassium carbonate anhydrous (250 g) in 50 liter of water. These carat containing grapes were dipped in the solution for 2 minutes and it was removed.

D. Flow sheet of raisins making process

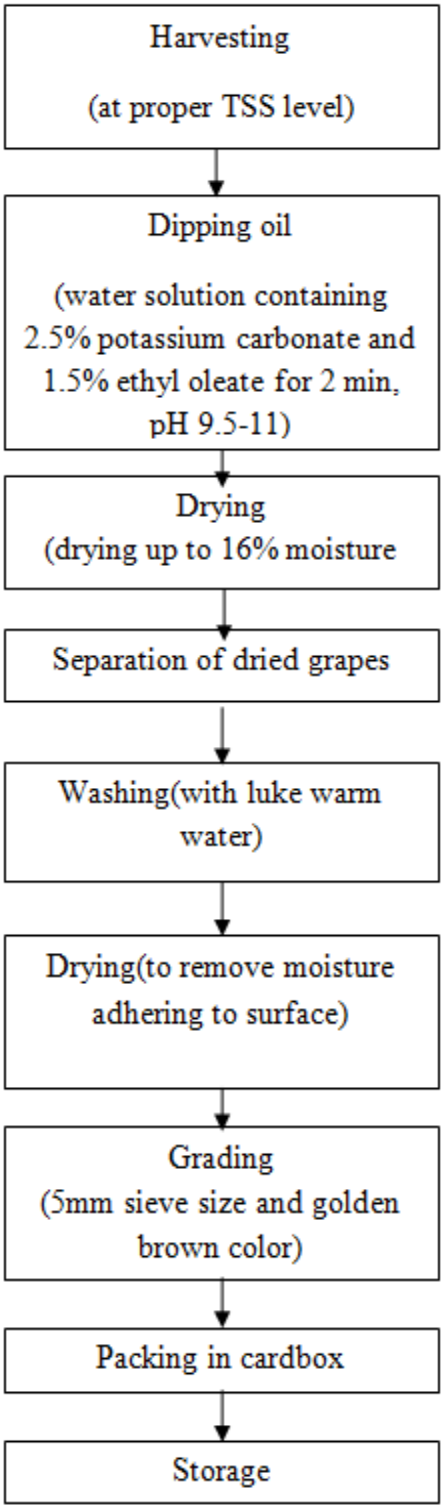

Fig 1:- Flow chart of raisins preparation

E. Drying methods

➢ *Open drying*

Grapes pre-treated are spread on a platform in a thin layer directly exposed to the sun. During sun drying process, part of the solar radiation penetrate the material and be absorbed within the grape itself, thus generating heat in the interior of the material as well as at its surface, therefore, increasing the heat transfer and enhances moisture evaporation. Usually time required in open drying is between 6 to 9 days depending on the weather conditions. The drying of grape was stopped when it reaches to desired state of dryness that is 15-16% moisture content.

➢ *Shade drying*

Shade drying is also a kind of natural method and extensively used for grape drying. It is also known as natural rack dryer. Pre-treated grapes were placed on the rack of dimension of 250*150*30 cm^3 and capacity of 500kg. The ambient air is the principal source of heat required for drying. Raisin of shade drying obtained better colour than sun drying, avoid the directly contact with sun rays. Time required in shade drying is between 12 to 15 days depending on the weather conditions. The drying of grape was stopped when it reaches to desired state of dryness that is 15-16% moisture content.

Fig 2:- Open shade drying

➢ *Controlled shade drying*

It is same as a shade drying where temperature and humidity are controlled as per the requirement. In controlled shade drying, the sensors are placed with heater and air blower. The sensors starts on low temperature range and stops when it reaches to higher temperature set as per the requirement. The temperature and humidity were set in the range of 30-42ºC and 6-20%.The dimensions of controlled shade drying cabinet were 250*150*30 cm^3 and capacity of 500kg. Time required in controlled shade drying is between 10 to 13 days depending on the inner cabinet conditions. The drying of grape was stopped when it reaches to desired state of dryness that is 15-16% moisture content.

Fig 3:- Controlled shade drying

➢ *Tray drying*

In this type of drying tray drier were used, which consisted of three basic section- an air blowing section, air heating section, and a drying chamber. The drying compartment consisted of trays, placed perpendicularly to the airflow. The grapes were placed in a single layer over the tray and inserted into the dryer cabinet, after operating conditions had been achieved. The tray containing samples was weighted at regular interval time drying runs were carried out at a constant temperature and air velocity. The temperature kept in tray drying was 35ºC The dimension of tray was 80*40 cm^2 and capacity of 25kg. Time required in tray drying is between 3 to 5 days. The drying of grape was stopped when it reaches to desired state of dryness that is 15-16% moisture content.

Fig 4:- Tray drying

F. Different drying parameters of drying system

➢ *Dry bulb temperature*

It is the temperature of air recorded by the thermometer with a dry bulb and denoted by T. It indicates the amount of heat in the air and is directly proportional to the mean kinetic energy of the air molecules.

➢ *Wet bulb temperature*

It is the temperature of air recorded by the thermometer with the bulb covered by a piece of wet cloth. Wet bulb temperature is less than dry bulb temperature.

➢ *Relative humidity*

RH is the ratio of the partial pressure of water vapour in the mixture to the partial pressure of water vapour in saturated air at same dry bulb temperature and pressure. Hygrometer was used to determine the relative humidity.

$RH = p_{wv} / p_s * 100$

➢ *Air flow rate*

Air flow is the movement of air from one area to another. Anemometer was used for measuring the speed of wind.

➢ *Bed thickness*

Bed thickness is the distance between the top and base berries measured perpendicular to the top. Bed thickness was calculated with the help of a scale. The average of five points were taken.

G. Drying characteristics of raisin process

➢ *Drying rate*

Drying rate is either the mass of water removed per unit time per unit mass of dry matter (denoted as Φ) or the mass of water removed per unit time per unit area (water flux denoted by N).

➢ *Drying time*

The time required to achieve a desired state of dryness can be found by integrating the expressions for drying rate with respect to time. The time required to achieve a desired state of dryness can be found by integrating the expressions for drying rate with respect to time.

➢ *Dehydration ratio*

It is the ratio of fresh grape berries to the final dried raisins. Moreover, the ratio of the product has been calculated by dividing the fresh weight of grape berries with weight of final dried berries.

Dehydration ratio was determined by using following equation.

$$\text{Dehydration ratio} = \frac{Weight\ of\ raw\ material\ (g)}{Weight\ of\ dehydrated\ material\ (g)}$$

➢ *Physiological loss in weight*

Physiological loss weight is determined by using equation.

$$\text{PLW} = \frac{Intial\ weight - Final\ weight}{Intial\ weight} \times 100$$

H. Sensory evaluation

The sensory evaluation of different organoleptic properties namely colour, taste, texture and overall acceptability were carried out by panel members. The 9 point hedonic scale was used for sensory evaluation of dried grapes (raisins).Samples were coded using random one digit numbers. Panelists were provided with a glass of water and instructed to rinse and swallow water in between the samples to break the monotony in taste of the dried grapes. Mean sensory scores for quality attributes colour, taste, texture and overall acceptability were recorded. The ranks were determined from the scores given by the judges. The sensory evaluation score sheets were provided to panellist. The results obtained from the sensory evaluation of the dried grapes are depicted in plate 3.7.

Fig 5:- Sensory evaluation of raisins

I. Statistical Analysis

The sensory evaluation results obtained were statistically analyzed by Completely Randomized Design (CRD) for different treatments as per the method given by Panse and Sukhatme (1987). The analysis of variance revealed at significance of P<0.05 level, S.E. and C.D at 5% is mentioned whenever required.

III. RESULTS AND DISCUSSION

The results of the present study entitled "Study on drying characteristics of grape raisins by using different drying methods" are presented and discussed in this chapter.

A. Drying parameters

➢ *Moisture content v/s Time*

Fig 6 shows the drying curve for grapes in the open drying. It was observed that the removal of moisture increased due to increase in temperature between 10.00h and 17.00h but decreased thereafter, which shows the earlier and faster removal of moisture from the dried item.

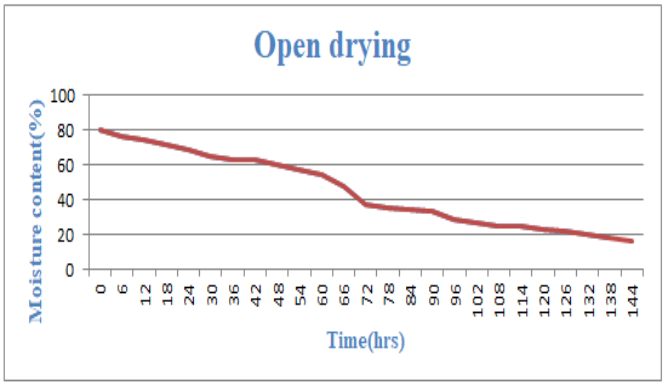

Fig 6:- Moisture Content(%) v/s Time(hrs) in open drying

Fig 7 shows the drying curve for grapes in the open shade drying. It was observed that the removal of moisture increased due to increase in temperature between 11.00h and 16.00h but decreased thereafter, which shows the earlier and faster removal of moisture from the dried item.

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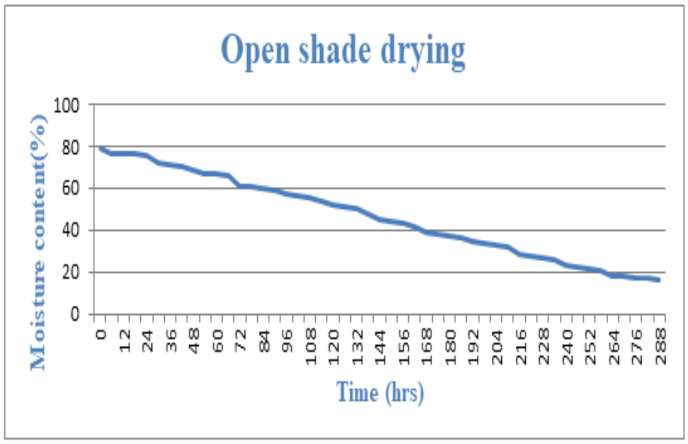

Fig 7:- Moisture Content(%) v/s Time(hrs) in open shade drying

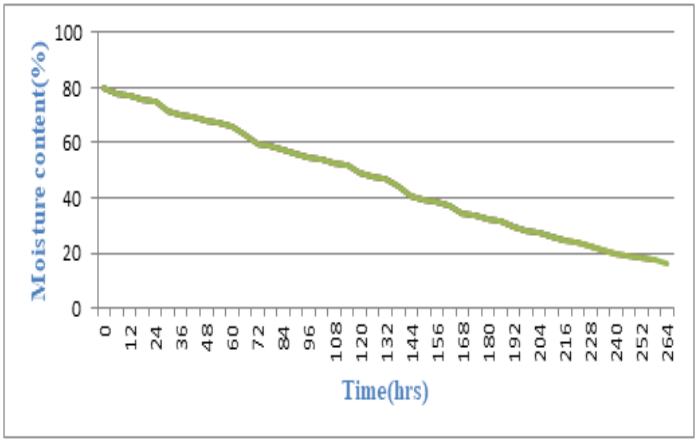

Fig 8:- Moisture Content(%) v/s Time(hrs) in Controlled shade drying

Fig 8 shows the drying curve for grapes in the controlled shade drying. It was observed that the removal of moisture was constant as the temperature (30ºC to 40ºC) and relative humidity (5% to 20%) was constant in the particular range.

Fig 9 shows the drying curve for grapes in the tray drying. It was observed that the removal of moisture increased as the time increases due to constant temperature (35ºC), which shows the earlier and faster removal of moisture from the dried item.

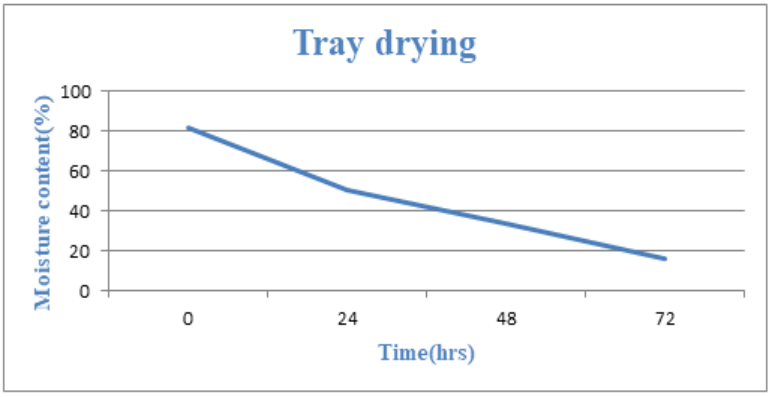

Fig 9:- Moisture Content(%) v/s Time(hrs) in tray drying

B. Physico-chemical properties of raisin

Sr. No.	Parameters	Fresh grapes	Raisins			
			Open drying	Open shade drying	Controlled shade drying	Tray drying
1	Moisture content (%)	79.89	15.97	16.02	16.19	16.34
2	T.S.S. (ºBrix)	23.90	69.30	68.70	68.50	68.20
3	Acidity (%)	0.33	0.31	0.30	0.30	0.31
4	pH	3.29	4.10	3.98	3.90	3.86
5	Average length (cm)	0.64	0.45	0.45	0.47	0.46
6	Average diameter(cm)	0.52	0.28	0.27	0.29	0.28
7	Surface area(cm^2)	0.33	0.12	0.12	0.10	0.13
8	Surface volume(cm^3)	0.21	0.06	0.06	0.05	0.21
9	Skin thickness(mm)	0.644	0.302	0.303	0.302	0.301
10	Bulk density(kg/m^3)	517	626	629	628	620
11	True density (kg/m^3)	1104	1241	1255	1248	1235
12	Porosity (%)	53.17	49.52	49.89	49.64	49.79

Table 1:- Comparison of Physico-Chemical properties of raisins in different drying methods

C. Comparison of drying characteristics

Sr. No.	Parameters	Open drying	Open shade drying	Controlled shade drying	Tray drying
1	Drying time (Days)	7- 8	13-14	11-12	3(at 35ºC)
2	Dehydration ratio	3.30	3.03	2.94	2.91
3	PLW (%)	69.70	67.00	66.00	65.60
4	Bed thickness (cm)	6.50	6.80	7.60	4.20
5	Diameter(cm)	0.277	0.279	0.300	0.284
6	Length(cm)	0.458	0.458	0.481	0.472
7	Bulk density(kg/m^3)	626	631	631	619
8	True density(kg/m^3)	1241	1259	1247	1227
9	Porosity(%)	49.52	49.88	49.40	49.55

Table 2:- Comparison of drying characteristics

The drying time required for preparation of raisins by different drying methods was 7-8 days in open drying, 13-14 days in open shade drying, 11-12 in controlled shade drying and 3 days in tray drying. The dehydration ratio was in the range of 2.91 to 3.30. Physiological loss in weight (PLW) during raisins process was found in the range of 65.60 to 69.70 percent in 'Thompson seedless'. The bed thickness varied in different drying methods measured by scale. It was 6.50cm in open drying, 6.80cm in open shade drying, 7.60cm in controlled shade drying and 4.20cm in tray drying.

D. Sensory Evaluation of Raisins

Samples	Colour/Appearance	Texture	Taste	Flavour	Acceptability	Avg.
C	8.4	8.1	8.3	8.0	8.3	8.22
A1	6.1	6.3	6.2	6.4	6.2	6.24
A2	6.2	6.4	6.4	6.3	6.5	6.36
A3	7.3	7.4	7.4	7.3	7.6	7.4
A4	7.8	7.1	7.3	7.1	7.3	7.32
SE ±	0.24198	0.20858	0.21061	0.20786	0.20084	-
CD @ 5%	0.72844	0.62788	0.63399	0.62571	0.60459	-

Table 3:- Sensory evaluation of raisins

***Each value is an average of 10 responses**
Where,
C- Control sample
A1- Open drying sample
A2-Open shade drying sample
A3- Controlled shade drying sample
A4-Tray drying sample

The mean score for colour/appearance of the raisins prepared by different drying methods ranged from 6.1 to 8.4 in 'Thompson seedless'. The highest score was obtained in sample A4 and lowest in sample A1 when compared to control sample. The mean score for texture of the raisins prepared by different drying methods ranged from 6.3 to 8.1 in 'Thompson seedless'. The highest score was obtained in sample A3 and lowest in sample A1 when compared to control sample. The mean score for taste of the raisins prepared by different drying methods ranged from 6.2 to 8.3 in 'Thompson seedless'. The highest score was obtained in sample A3 and lowest in sample A1 when compared to control sample. The mean score for flavour of the raisins prepared by different drying methods ranged from 6.3 to 8.0 in 'Thompson seedless'. The highest score was obtained in sample A3 and lowest in sample A1 when compared to control sample. The mean score for acceptability of the raisins prepared by different drying methods ranged from 6.2 to 8.3 in 'Thompson seedless'. The highest score was obtained in sample A3 and lowest in sample A1 when compared to control sample.

IV. CONCLUSIONS

Grape is one of the most important fruit crop in the world due to its nutritional and therapeutic value. It is a good source of dietary sugars, organic acids, excellent source of dietary fibres, some amount of minerals and vitamins.

The moisture content of fresh fruits of 'Thompson seedless' was 79.89 percent measured by hot air oven method. The moisture content of raisins decreased to 15.97 percent in open drying, 16.02 percent in open shade drying, 16.19 percent in controlled shade drying and 16.34 percent in tray drying. The total soluble solids content of fresh fruits of 'Thompson seedless' was 23.9 ºBrix measured by Erna hand refractometer. The total soluble solids of raisins increased to 69.3ºBrix in open drying, 68.7ºBrix in open shade drying, 68.5ºBrix in controlled shade drying and 68.2ºBrix in tray drying. The acidity of fresh fruits of 'Thompson seedless' was 0.3264 percent measured by titrable acidity. The titrable

acidity of raisins decreased to 0.300 percent in open drying, 0.302 percent in open shade drying, 0.309 percent in controlled shade drying and 0.310 percent in tray drying.

The pH content of fresh fruits of 'Thompson seedless' was 3.29 measured by pH meter. The pH of raisins increased to 4.1 in open drying, 3.98 in open shade drying, 3.9 in controlled shade drying and 3.86 in tray drying. The average length of fresh fruits of 'Thompson seedless' was 0.637 cm measured by vernier calliper. The average length of raisins decreased to 0.457cm in open drying, 0.458 cm in open shade drying, 0.471 cm in controlled shade drying and 0.459 cm in tray drying.

The mean score for colour/appearance, texture, taste, flavour and acceptability of the raisins prepared by different drying methods ranged from 6.1 to 8.4, 6.3 to 8.1, 6.2 to 8.3, 6.3 to 8.0 and 6.2 to 8.3 respectively. From the different drying methods carried out, the following conclusions were made. Open drying (Sun drying) is widely used due to its low initial and running costs but depend mainly on weather conditions, which can induce microbial and insect contamination and hence, lower their quality. Drying rate and drying time was faster in tray drying compare to others three drying methods but the disadvantage of tray drying was it is batch process and cannot be used for mass production and the consumption of power is more. The quality of raisins from sensory evaluation were highly accepted in controlled shade drying where temperature and humidity was maintain as per the requirement and least accepted in open drying. Controlled shade drying found better drying method compared to other methods as it is a continuous process and less chances of contamination and high quality of product is obtained.

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