Effects of pretreatments and drying methods on nutritional and sensory quality of raisin


Abstract
A study with three drying methods i.e., cabinet tray dryer, solar tunnel dryer and open sun drying methods with four pretreatments such as, ethyl oil and K$_2$CO$_3$, olive oil and K$_2$CO$_3$ and hot water blanching was undertaken to evaluate the effects of pretreatment and drying methods on nutritional quality and sensory attributes of raisins. Moisture content of grapes variety of Thompson seedless was reduced bellow 16 per cent. Raisins pretreated with ethyl oleate oil 1.5 per cent + K$_2$CO$_3$ 3 per cent and dried in cabinet tray dryer had least non-enzymatic browning (0.049), highest carbohydrate (79.42 g 100 g$^{-1}$), minimum titratable acidity (1.80%) and crud fiber (1.11 g 100 g$^{-1}$) but, highest non-enzymatic browning, lower nutritional value and low sensory scores recorded for sun dried raisins without dipping pretreatment.

Keywords: raisin, pretreatment, drying methods, nutritional value, sensory attributes

Introduction
Grape (Vitis vinifera L.) is a nutritious fruit crop which is highly suitable for fresh consumption and development of value added products. Grape is grown in most part of the world where Italy, France, United States of America, Spain and China are the top five grape producer countries (Wang et al., 2016) [1]. Fresh grapes which contain about 75-80 per cent moisture are sensitive to physiological and microbial activities such as respiration, transpiration and spoilage during storage (Xiao et al., 2010) [2]. Grape can be consumed fresh, dried (raisin), or value added products such as wine, juice, jam, etc. Most of nutrients including carbohydrates, sugars, crude fiber and phytochemicals concentrate in raisins by reduction of moisture content with longer shelf life. Raisins is a popular dried fruit with high antioxidant activity which consumed directly as snack or process to wine and juice with high global demand. Raisin making or dehydration of grape is complex process compare to drying of other fruits because of presence of wax layer on the surface of grape berries which prevents from fast moisture diffusion and extend the drying time (Casado and Heredia, 1999) [3]. Application of pre drying treatment is a key step to remove the waxy cuticle of berries before drying (Esmailli et al., 2004) [4]. Chemical, physical and blanching are common methods to disturb the wax layer on grape surface to enhance drying rate (Wang et al., 2016) [1]. Potassium carbonate (K$_2$CO$_3$), sodium hydroxide (NaOH), sodium bicarbonate (NaHCO$_3$), ethyl oleate and olive oil are the main compounds being used as chemical pre-treatment. Apart from pretreatment, the drying method has a great effect on drying time and physico-chemical quality of raisin (Yang et al., 2009) [5]. Sun, solar, shade and mechanical drying are common grape drying methods all across the raisins production areas. Lack of ability to control the drying operation, prolonged drying time, weather uncertainties, high labour costs, large area requirement, insect infestation, mixing with dust and other foreign materials limits the application of natural sun drying (Toğrul and Pehlivan, 2004) [6]. The solar drying is different from sun drying in way that instead of open sun drying, the commodities are dried in a chamber or in a tunnel which is covered with semitransparent polyethylene (Esmailli et al., 2004) [4]. Mechanical drying is widely used in raisin production due to its rapid, controllable, low labour, and high quality of products (Wang et al., 2016) [1].

Material and Methods
Raw material: The fresh grapes (var. Thompson seedless) with uniform bunches, size, color, maturity, free from visible damages and free from GAs were harvested directly from field (Sangli, Maharashtra), carefully packed in corrugated fiber board boxes and transported to Postharvest Technology Laboratory, Bengaluru. The total soluble solids content of grapes was 24°Brix and moisture content was 71-74 per cent. The average weight of grape bunches was...
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significant difference registered for the interaction effects between pretreatments and drying methods. The dipping pretreatments by ethyl oleate oil in cabinet tray dryer (T1M1) had superior TSS (Fig.1) which was in agreement with finding of Jadhav et al. (2010) [10]. Cabinet tray dryer helps in quick removal of moisture from berries with enhanced quality retention, while ethyl oleate facilitates moisture removal and glassy appearance.

**Titratable acidity**
The titratable acidity of fresh grapes which was used for raisin making was 0.81 per cent. Titratable acidity of raisins ranged from 1.95 to 2.78 (%) regarding different pretreatments which is applied in this experiment. The raisins which prepared without dipping pretreatment were recorded significantly higher titratable acidity as compared to raisins dipped in ethyl oleate and olive oil with potassium carbonate emulsion (Fig.3). Lower titratable acidity in T1 (1.5% Ethyl Oleate Oil + 3% K2CO3) and T2 (1.5% Olive Oil + 3% K2CO3) may be due to the use of 3 per cent potassium carbonate emulsion with ethyl oleate or olive oil, which is basic in nature and neutralized the acidity of raisins. This result is in agreement with findings of Mandal and Thakur (2015) [12], where the acidity of raisins reduced in 0.3 per cent lye solution compare to other pretreatment. It was seen that, titratable acidity is inversely proportionate to the total soluble solids present in raisins in all pretreatment and drying methods. The acidity of raisins was influenced with different drying system. The highest (2.50 %) acidity was found in open sun dried raisins but minimum (2.07%) was recorded in raisins prepared under in cabinet tray dryer.

**Crude fiber**
The crude fiber in raisins prepared by different pretreatment ranged from 1.14 to 1.76 g 100 g⁻¹ (fig. 4). The similar result (1.18%) was reported by Kumar (2009) [13] for Thompson seedless raisins. The lower crude fiber in raisins, pretreated by ethyl oleate and olive oil with potassium carbonate emulsion is possibly due to destruction of fiber content in cell wall of grapes skin by potassium carbonate to develop cracking in the surface of berries. This result was supported by Camire and Dougherty (2003) [14], which reported that, insoluble fiber in raisins is affected by dipping lye pretreatment.

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**Fig 1:** Effect of different pretreatments, drying methods and their interaction on total soluble solids of raisins.

**Fig 2:** Effect of different pretreatments, drying methods and their interaction on total carbohydrates of raisins.

**Fig 3:** Effect of different pretreatments, drying methods and their interaction on titratable acidity of raisins.

**Fig 4:** Effect of different pretreatments, drying methods and their interaction on crude fiber of raisins.
Total antioxidant activity of raisins

The total antioxidant activity of raisins ranged from 431.01 to 330.63 mg 100g⁻¹ in T₁ (1.5% Ethyl Oleate Oil + 3% K₂CO₃) and control treatment, respectively (Fig. 5). Breksa et al. (2010) [15] also reported that Golden, Thompson seedless raisins treated with sulphur dioxide had significantly higher phenolic compound than dipped in hot water or sun-dried Thompson seedless raisins. Raisins which prepared under different drying methodology showed variation in total antioxidant activity. The total antioxidant activity ranged from 328.06 in sun dried raisins to 349.81 in cabinet dried raisins. This result is supported by Kaliora et al. (2009) [16] that revealed which golden color Thompson seedless raisins have significantly higher antioxidant activity as well as higher total phenolic contents than sun-dried Thompson seedless raisins. The variation possibly could be because of enzymatic activity which is reduced phenolic content and antioxidant activity in sun dried raisins (Breksa et al., 2010) [15].

Non-enzymatic browning (NEB)

The NEB of raisins significantly affected by dipping pretreatments which ranged from 0.18 in T₁ to 0.71 OD at 440nm in T₄ (Fig 6). The dipping pretreatments of grapes in ethyl oleate and olive oil with potassium carbonate in all methods of drying were having lower non-enzymatic browning (NEB) and superior color than hot water blanching. This result is support by Doreyappa et al. (1998) [17], was reported that NEB of raisins was affected by pretreatment and showed that Golden bleach hot dip pretreatment had lower browning values. The non-enzymatic browning (OD values at 440 nm) in different drying methods were 0.29, 0.30 and 0.59 in cabinet, solar and sun drying, respectively. Higher NEB values in sun and solar dried raisins is may be due to drying at inconsistent temperature and slow drying rate, which is not a rapid drying process led to more browning in raisins. With respect to interaction effects of pretreatments and drying methods the non-enzymatic browning of raisins ranged from 0.05 (M₁T₁) to 0.84 (M₄T₄). The similar finding reported by Burcak and Amet, (2015) [18], where alcohol soluble color of raisins was more in natural sun drying than raisins pretreated with sodium hydroxide and dried in solar tunnel dryer.

Sensory evaluation of raisins

The raisins pretreated by ethyl oleate oil with potassium carbonate emulsion were superior in recording bright colour and appearance than other pretreatments in all methods of drying. The raisins prepared in this method through sulphuring of grapes resulted light green, golden yellow and dark brown coloured raisins in cabinet, solar and open sun drying respectively. Raisins pretreated in olive oil with potassium carbonate emulsion had same color but little darker and oily surface than ethyl oleate dip method in all three methods of drying The hot water blanching and control were dark in color and not much attracted by sensory panel. (Fig 7). The pretreatments of raisins in ethyl oleate and olive oil with potassium carbonate have given good textured raisins in cabinet dryer than others. Most of the raisins prepared in solar tunnel dryer and open sun are little hard and not uniform texture, may be due to inconsistent viz. prolonged drying and more browning. Similarly Almeida et al. (2015) [19] reported that raisins prepared in different drying systems obtained different sensory texture scores. Ethyl oleate and olive oil with potassium carbonate dipping pretreatment had equally performed to good taste than hot water blanching in all methods of drying. The raisins which pretreated in ethyl oleate and olive oil with potassium carbonate were more attractive and obtained maximum overall acceptance than hot water blanching and control in all three methods of drying (Fig 7). The raisins which dried faster had bright color such as light green, golden brown and dark brown in cabinet, solar and open sun drying respectively which might has influenced for maximum overall acceptability. The ethyl oleate dip raisins were more attractive with acceptable texture and found highest overall acceptability score (8.5 out of 9) same treatment in solar tunnel dryer and open sun drying obtained 8.13 and 6.72 out of 9.

Fig 5: Effect of different pretreatments, drying methods and their interaction on antioxidant activity of raisins.

Fig 6: Effect of different pretreatments, drying methods and their interaction on non-enzymatic browning of raisins.

Fig 7: Effect of different pretreatments, drying methods and their interaction on sensory attributes of raisins.
Conclusion
Pretreatment and drying method are two critical factors for production of high quality raisins. The ideal combination of pretreatment (ethanol olate oil 1.5% + K2CO3 3%) and drying method (cabinet tray and solar tunnel dryer) produce raisins with high nutritional quality, desirable sensory attributes, saves energy, time, labor and maintain high hygienic standards.

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References