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RESEARCH ARTICLE

Texture profile analysis of Sonaka and Thompson seedless raisins

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ABSTRACT

Texture Profile Analysis (TPA) is a well developed and reliable method for measuring firmness of fruits and dehydrated products. In the present investigation, an attempt has been made to study texture profile of raisins of Sonaka and Thompson seedless treated with $MgCO_3$, K2CO_3, $CaCO_3$ and Sulphur and coated with Zein protein. Results indicated that hardness of raisins of both varieties was increased due to Zein protein coating and sulphur treatment. The adhesiveness of sulphur treated and Zein coated raisins was reduced in Thompson seedless variety. The raisins of Sonaka and Thompson seedless variety had the least cohesiveness under sulphur, Zein protein coating indicated that both treatments improved durability of and deformation of raisins during post harvest storage. From these results it is concluded that application of sulphur and Zein protein coating on raisins of Sonaka and Thompson seedless is beneficial for maintenance of overall texture of raisins during storage and transport.

Keywords: Raisins, Sonaka, Sulphur, Thompson seedless, TPA, Zein protein

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INTRODUCTION

Grape (*Vitis vinifera* L.) belonging to family Vitaceae is a commercially important fruit crop of India. Grapes are eaten as raw or they can be used for making wine, raisins, jam, and jelly, which are very nutritious and rich source of minerals like potassium, phosphorus, calcium, magnesium and other micronutrients and different vitamins. The dried grapes, commonly known as raisins, have a great importance in economy of the country and considered as one of the nutritious most popular dry fruits in the world. Raisins are dried fruits of certain varieties of grapevines with a high content of sugar and solid flash (Khair and Shah, 2005). The important raisin grape varieties are Thompson seedless and their selections like Tas-A-Ganesh, Sonaka and Manikchaman. The increased production of table grapes has a great potential to produce raisins with minimum losses of fresh fruits (Telis et al., 2004).

Texture profile analyses (TPA) is a well developed and reliable method for measuring firmness of fruits and dehydrated products (Harker et al., 2006) and has been utilized for measuring the physical properties of plant tissue (Bourne, 2002 and Roudot, 2006) mostly from wide range of food and vegetables (Chang et al., 2012, Kulamarva et al., 2009 and Cardoso et al., 2009). TPA provides sensory signals to consumers (Civille, 2011) and thus it stands as one of the measures in the food chain used to estimate the quality of different cultivars at technological ripeness and during storage (Paoletti et al., 1993 and Johnston et al., 2000).

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In the present investigation, an attempt has been made to study texture profile of raisins of Sonaka and Thompson seedless treated with $MgCO_3$, K_2CO_3, $CaCO_3$ and Sulphur and coated with Zein protein. Present study may be beneficial to farmers for post harvest storage of raisins

MATERIALS AND METHODS

Raw Martial

The grapes of two varieties viz. Sonaka and Thompson seedless were harvested at Malgaon (Tahsil- Miraj, District- Sangli, Maharashtra, India) when they were fully ripened, having sugar percentage more than 21' brix. It required nearly 130 to 150 days for harvesting the grapes for raisin preparation. For raisin preparation, grapes were harvested early in the morning and treated with different chemicals as follows:

$MgCO_3$, $CaCO_3$ and K_2CO_3 were taken in different concentrations of 10, 15, 20, 22, 23, 24, 25, 26 and 30 mg/liter in buckets and after stirring and dissolving the chemicals, 18 ml olive oil were mixed. A dipping oil ethyl oleate was kept constant 18 ml/liter of water in all pre-treatment chemical samples.

Texture profile analysis (TPA)

Texture Profile Analysis was carried out to determine the quality of raisins pretreated with different treatments. Single treated raisin had been used for the texture profile analysis. For the estimation of texture quality, instrument called TA-XT2 Plus, Texture Analyser, made by Stable Micro System, London had been utilized. The settings used for the analysis was: Pre Test Speed- 1.00 mm/sec, Test speed - 5.00 mm/sec, Post Test Speed- 5.00 mm/sec, Target Mode- Strain at 40%, Test Time- 5 sec, Probe - P/75 mm Compression Platen and Data Acquisition Rate: 200 pps (parts per sec).

RESULTS AND DISCUSSION

Texture Profile Analysis

The texture profile analysis of Sonaka and Thompson seedless raisins is shown in the Table 1. It is noticed that the hardness of Sonaka seedless raisin is less than that of Thompson seedless raisins treated with $MgCO_3$, K_2CO_3 and $CaCO_3$. While, the raisins treated with Sulphur and coated with Zein protein shows remarkable increase in the hardness of Sonaka than the Thompson seedless raisins. It is also noticed that the hardness of, Sulphur and coated with Zein protein raisins is significantly increased than uncoated raisins.

It is clear from Table 1 that the adhesiveness of, Sulphur and Zein protein coated raisins of Thompson seedless variety has been significantly decreased than the treated control raisins. While, in case of raisins of Sonaka variety adhesiveness is slightly altered. The springiness of raisins of Sonaka and Thompson seedless variety is almost similar and due to the Sulphur and Zein protein coating the springiness of raisins remains unchanged or slightly altered (Table 1). The cohesiveness of raisins of Sonaka and Thompson seedless variety is significantly decreased in, Sulphur and Zein protein coated raisins than the controlled raisins (Table 1).

It is evident from Table 2 that the gumminess of raisins of Thompson seedless variety is slightly decreased due to Sulphur and Zein protein coating treatment than the control, while, the raisins of Sonaka seedless variety shows increase in the gumminess due to pretreatment with , Sulphur and Zein protein coated than the control raisins. The chewiness of both the varieties of Sonaka and Thomson seedless raisins has been elevated due to, Sulphur and Zein protein coating pretreatment than the control pretreatment (Table 1) while the resilience of Sonaka and Thompson seedless variety raisins is slightly decreased due to the pretreatment of, Sulphur and Zein protein coating than the control pretreatment (Table 1).

Table 1. Texture Profile Analysis of raisins of Sonaka and Thompson seedless under different chemical treatments.

Test ID	Force 1 g	Area-FT 1:2 g sec	Time-diff. 1:2 sec	Area-FT 1:3 g sec	Area-FT 2:3 g sec	Area-FT 4:6 g sec	Time-diff. 4:5 sec	Hardness g	Adhesiveness g.sec	Springi-ness	Cohesive-ness	Gummi-ness	Chewi-iness	Resilience
TPA 1	**1222.38**	**150.81**	**0.661**	**201.44**	**50.63**	**141.31**	**0.594**	**1363.1**	**-0.64**	**0.89**	**0.7**	**955.02**	**856.40**	**0.33**
S.D.	273.20	38.805	0.096	53.03	15.07	39.469	0.1	305.96	0.29	0.03	0.02	227.43	214.90	0.036
C. V	22.35	25.731	14.47	26.32	29.78	27.93	16.88	22.446	-45.02	4.12	3.69	23.815	25.09	10.58
TPA 2	**454.36**	**60.79**	**0.648**	**79.92**	**19.12**	**57.61**	**0.734**	**504.27**	**-0.147**	**1.14**	**0.72**	**368.18**	**527.6**	**0.29**
S.D.	388.50	35.285	0.034	49.163	14.42	37.013	0.25	422.29	-	0.44	0.074	328.89	669.44	0.062
C. V	85.505	58.038	5.218	61.512	75.43	64.24	34.11	83.742	-	38.63	10.18	89.32	126.86	20.66
TPA 3	**1153.6**	**157.97**	**0.523**	**196.54**	**38.56**	**130.40**	**0.409**	**1281.1**	**-0.46**	**0.78**	**0.66**	**850.51**	**664.07**	**0.244**
S.D.	208.82	36.27	0.014	44.852	9.012	26.084	0.023	241.09	0.088	0.028	0.026	133.97	99.56	0.023
C. V	18.103	22.95	2.762	22.8	23.36	20.03	5.594	18.82	-19.172	3.55	3.904	15.753	14.99	9.328
TPA 4	**874.57**	**155.76**	**0.558**	**187.58**	**31.82**	**122.04**	**0.43**	**989.26**	**-0.163**	**0.77**	**0.65**	**643.88**	**497.15**	**0.205**
S.D.	40.33	7.157	0.049	4.807	2.405	7.85	0.028	55.983	0.172	0.04	0.058	56.49	43.23	0.026
C. V.	4.612	4.595	8.863	2.562	7.557	6.43	6.578	5.659	-105.93	5.15	8.846	8.775	8.69	12.541
TPA 5	**1320.58**	**265.66**	**0.608**	**317.40**	**51.73**	**146.63**	**0.436**	**1655.8**	**-0.33**	**0.72**	**0.54**	**786.19**	**548.24**	**0.213**
S.D.	646.24	187.20	0.068	212.94	26.51	49.66	0.084	955.94	0.198	0.122	0.16	261.22	149.2	0.045
C. V.	48.93	70.46	11.25	67.091	51.24	33.86	19.233	57.733	-58.54	16.97	29.46	33.22	27.21	20.975
TPA 6	**629.66**	**113.59**	**0.631**	**145.46**	**31.87**	**100.73**	**1.121**	**701.91**	**-0.173**	**1.74**	**0.706**	**483.33**	**768.06**	**0.283**
S.D.	252.57	44.42	0.073	55.73	11.47	32.11	1.074	290.04	-	1.61	0.07	163.48	591.2	0.018
C. V	40.11	39.10	11.63	38.312	36.06	31.88	95.748	41.322	-	92.59	9.99	33.823	76.97	6.432
TPA 7	**1313.93**	**292.49**	**0.718**	**349.03**	**56.54**	**199.86**	**0.548**	**1513.8**	**-0.18**	**0.76**	**0.58**	**891.79**	**685.53**	**0.207**
S.D.	119.01	76.04	0.051	71.737	4.445	11.98	0.028	99.299	0.23	0.031	0.104	198.08	181.15	0.079
C. V	9.058	26	7.144	20.553	7.862	5.99	5.185	6.559	-127.12	4.046	17.75	22.212	26.42	38.173
TPA 8	**1652.48**	**346.35**	**0.596**	**413.26**	**66.91**	**230.47**	**0.469**	**1957.02**	**-0.17**	**0.78**	**0.55**	**1094.42**	**854.17**	**0.192**
S.D.	435.65	63.70	0.05	79.741	16.18	58.26	0.046	503.972	0.13	0.033	0.038	342.64	243.83	0.013
C. V	26.36	18.39	8.439	19.295	24.18	25.28	9.753	25.752	-80.44	4.24	6.91	31.308	28.54	6.853

S.D. – Standard Deviation; **C.V.** – Coefficient of Variance, **TPA-1:** Thompson seedless treated with $MgCO_3$; **TPA-2**: Sonaka seedless treated with $MgCO_3$; **TPA-3**: Thompson seedless treated with K_2CO_3; **TPA-4**: Sonaka seedless treated with K_2CO_3; **TPA-5:** Thompson seedless treated with $CaCO_3$; **TPA-6:** Sonaka seedless treated with $CaCO_3$; **TPA-7**: Thompson seedless treated with K_2CO_3+Sulpher Fumigated and coated; **TPA-8:** Sonaka seedless treated with K_2CO_3+Sulpher Fumigated and coated.

According to Civille (2011), the mechanical properties viz. hardness, cohesiveness, crispness, crunchiness and denseness of food are easy indicators of a product's freshness and wholesomeness. Texture profile parameters determined were as follows - firmness, cohesiveness, adhesiveness and chewiness (Besbes et al., 2009). In this respect, there has been a great interest in developing methods to predict and control the texture of the food, particularly in regard to the effects of processing like drying. According to Alvarez et al. (2002), it involves the puncture test method that is more linked to the skin texture indicating that fruit skin plays a great part in the overall firmness (Grotte et al., 2001). The analysis of the instrumental texture profile analysis (TPA) is one of the methods for determining the texture of food by simulation or imitation of repeated biting or chewing food (Almeida, 2013). Instrumental TPA or double compression test was based on the analysis of each intact berry, which was compressed twice with a 25% deformation 25 apart, in reciprocating motion imitating the action of the jaw (Maury et al., 2009). Textural properties of whole berry depend on different characteristics like cell - wall composition, cell structure and pulp turgescence, and therefore this mechanical test can be useful to follow grape ripening (Moigne et al., 2008).

Letaief et al. (2008) designated berry chewiness to be a dominant texture parameter in differentiating Italian varieties of grape. A significant varietal effect was observed for berry hardness, gumminess, springiness, chewiness and resilience on Merenzao varieties (Segade et al., 2011). Mechanical texture parameters were able to show the differences between grapes with different ripening levels (Maury et al., 2009). Marsilio et al. (2000) speculated that the textural properties as well as the appearance and flavor are the most influential organoleptic attributes for quality, which indicates the acceptability of food by consumers. The complex interactions between different components of the food resulted in the development of texture and the changes related with the texture of food during food processing are due to the structural changes in the cell (Marsilio et al., 2000).

According to Caine et al. (2003), hardness is the force required to compress a food between the teeth or between the tongue and mouth, i.e. the force required to cause deformation, while the elasticity is the ability to regain shape after compression, and measures the speed of return to the initial state after removal of the force which caused the deformation. They noticed that the elasticity value decreases with increasing temperature. The raisins obtained by solar drying are less elastic than those obtained by drying in a ventilated oven at 50°C and in turn less elastic than the grapes dried at 60°C. The results in the present study are in agreement with those obtained by Caine et al. (2003). The cohesiveness represents the internal forces in the food, and maintains the sample cohesive (Caine et al., 2003). They found that the results for the samples from the solar greenhouse and from the ventilated chamber at 50°C were similar, while the grapes dried at 60°C were less cohesive. Resiliency is the strain energy per unit volume to a limit of proportionality, i.e. the energy used when applying a force to a material without to occurring rupture, with or without any residual strain (Caine et al., 2003). The chewiness measures the energy required to disintegrate a food as to be swallowed (Caine et al., 2003), and these results are derived directly from the fact that these grapes have a higher hardness than the others. The mechanical characteristic of texture, which is commonly used to describe the rheological behavior of biological materials, is the Firmness (or hardness) and is generally defined as the maximum force required to achieve a specific strain in compression, puncture and cut tests (Peleg, 2006). The fact that the greater force in the longitudinal direction may be due to the location of the polysaccharide chains of the cell wall with respect to the load application as suggested by Mayor et al. (2007). The several investigators (Van Linden,V. 2007; Toivonen and Brummell, 2008 and Goulao and Oliveira, 2008) have reported as fruit ripeness that progresses, water loss occurs, which is associated with a loss of turgor of the cells, a decrease in adhesion between cells and changes in cell wall polysaccharides,.

In the present investigation the various parameters of texture were positively influenced due to pretreatments of chemicals and coating. The hardness of Zein protein coated raisins was increased than that of control. Thus, the increased hardness of raisins will improve the marked quality and durability of raisins due to the Zein coating and sulphur treatment.

The adhesiveness of sulphur treated and Zein coated raisins was reduced in the raisins of Thompson seedless variety. The decreased or low adhesiveness is an important property of dehydrated fruit which maintains the shelf life of raisins during post harvest storage of raisins thus the application of Zein coating is found to be beneficial for maintaining this textural property of this raisins.

The springiness of raisins of Sonaka and Thompson seedless variety was slightly altered or almost unchanged which indicate that the stability of raisins due to various pretreatment results in the better quality of raisins. Thus the maintenance of springiness thought, the treatment results in the maintenance of its normal size after compression pressure during the storage and transport. This will improve the market quality and acceptability of raisins by consumer.

The raisins of Sonaka and Thompson seedless variety had the least cohesiveness of sulphur, Zein protein coated, raisins which was slightly lowered thus the maintenance of less cohesiveness during the course of its storage indicates its maintenance of texture after second deformation. Thus, it can improve the overall durability and deformation of raisins during post harvest storage.

The slight change in gumminess of Thompson seedless raisins than in Sonaka seedless raisins was noticed which indicate that the elevation in gumminess of semisolid raisins is related to its hardness hence these changes in gumminess is correlated with the hardness of these to raisins varieties. Thus, this will definitely improves the overall storage and durability of this perishable product. The chewiness is property of solid product calculated with springiness and gumminess thus the slight changes in chewiness of raisins of Sonaka and Thompson seedless variety indicates positive influence of pretreatment on quality and consumer acceptability of raisins.

The resilience is measure of the single peak compression obtained after withdraw of first compression. In the present study, less resilience of raisins in these two verities was noticed which will be found beneficial for maintaince of overall texture of the raisins during storage and transport.

CONCLUSION

Considering the sensory evaluation, nutritive value and physio-chemical changes during storage the treatment combination T_2 that is 1: 1.25 pulp to sugar ratio of strawberry jam could be selected for commercial processing. After 6 months of storage under room temperature, the quality and the nutritional changes of strawberry jam was found satisfactory. For this regards it was concluded that strawberry jam may be stored up to 6 months at room temperature.

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