Features of raisins grape quality according to the drying process method used

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Abstract
The province of San Juan produces the 90% of grape raisins in Argentina. The main drying method uses solar energy on drying yards built with gravel. In the recent years, others drying methods have appeared: dry on vine, drying on structures or drying on plastics tarps. The raisins made by different method have different features about color, appearance, flavor, incrustations, mold or other kind of quality problems. This study assessed the quality characters in grape raisins drying by gravel yard, plastic tarps, metal structures and drying on vine. Up to 32 raisin samples were evaluated about physic features. Also organoleptic evaluation and ochratoxin A analysis were made. The data were process by SPSS 15.0 software. Descriptive statistic, ANOVA and cluster analysis were calculated. The results indicated the main problems were raisins out of range, discoloration, out of regular form, irregular wrinkle, crystallization, capstems, damage and spots. The method with the most sugar crystallization and caramelization process was drying by gravel yard. Plastic drying method had the most amount of incrustations or strange materials. Dry on vine raisins do not show any sign of mold or insects. Most percentage of substandard grade are found in plastic drying method. A cluster analysis showed gravel and plastic drying method are closer each other and dry on vine is similar to structure drying method. Gravel method have the most ochratoxin A content. Dry on vine and structure drying method are both the best option for a good raisin quality made on a farm.

Keywords: substandard raisins, ochratoxin, raisin weight, defects.

1 Introduction

All over the world raisin grape production has an annual variation from 1% to 2% (Espíndola et al, 2017). In 2017-18 the forecast raisin grape production was 1.2 million metric tons (t) because of a bigger production in China and a lower production in Turkey and United States (USDA, 2017). Argentina produces 40.000 t per year and does not have a government policy about raisin quality standards (Espíndola et al, 2014). The quality is one of the most important factor in world market (Doreste, 2013). United Stated Agriculture Department (USDA) check the raisin quality and determinate four categories A, B, C and Substandard. Some of the evaluated features are sugar content, moisture percentage, color, damage, mold, sunburn, sugaring, caramelization, extraneous material, and fermentations (Christensen, 2000). 13% moisture content is a right value for finishing the drying process. Low proportion of red color is associated to a good quality (Whiting, 2001). In Australia Sultanas raisin are graded into categories base on color ranging from amber to dark brown. In other situation raisin are classified mainly by uniformity of color, size and flavor. The raisin dry mass is 70 to 80% sugar so the soluble solids content is important to quality of raisin

(Parpinello et al, 2012). In general tray-dried raisins meet minimum quality when they are made from grapes with >19% soluble solids. Quality increases when grapes have >22% soluble solids. The drying method can affect the shape and surface texture of raisin and it influences the raisin quality (Christensen, 2000). In other situation, when a drying emulsion is used for a faster dehydration, the color and wrinkles are different than untreated grapes (Parpinello, et al, 2012). Dry on Vine (DOV) raisins are better graded than tray raisins at the same sugar content. The right maturity contributes with a positive way to flavor, sour and astringency. A finer wrinkle and a more compact shape are desirable qualities for raisins (Parpinello et al, 2012) and DOV system produce a better raisin quality (Fidelibus, 2007) but needs more time for finishing the drying process (Fidelibus et al, 2008). About drying period, raisins made by tray system last 10-15 days; DOV from 40 to 60 days depending on the weather and, in Argentina, in drying yard system the drying period lasts from 15 to 20 days and DOV system from 40 to 80 days depending on the variety and the weather. There is no a governmental department which regulate the raisin quality standards and the customer is who establish the quality expected during the negotiation. Raisin quality determinate the payment (Fidelibus et al, 2008). The objective of this study is to assess the raisin quality (color, size uniformity, shape, flavor, strange materials, damage, incrustation, crystallization, capstems, mold, out of range, spots, and other qualities), substandard raisin percentage, moisture percentage and ochratoxin A content from DOV system, gravel and plastic drying yard and structures drying.

2 Materials and method

Along 2017-2018 summer season Flame Seedless raisin were made under different drying methods and technologies. Different drying systems were built in Agriculture Experimental Station from National Agriculture Technology Institute (INTA), San Juan, Argentina. Gravel drying yard, plastic drying tarps (black and transparent) and drying structures were built, also DOV system was applied. Each drying plot had 20 m^2. The experimental unit was 20 kg fresh grape spread on 1 m^2 plastic net. All the grape was taken from the vineyard the harvest day. The grape harvest happened with 21° Brix. The drying process started for all the treatments at the same time. Flame Seedless DOV raisin also were taken from DOV plot located at the same INTA center. Cane severance for DOV were when grapes got 21 °Brix (the same sugar content that the others grapes). The half DOV´s vine were spray with drying emulsion. The raisin was picked up when it gets around 14% moisture measured by a visual end hand criteria. One-kilogram sample was taken from each experimental unit form the drying plots (four replicates each treatment) and sent to a laboratory (Lapriq Laboratory certificated, Engineer School, ISO 17.025 accreditation) for ochratoxin A analysis and moisture analysis.

2.2 Flame Seedless raisin production methods:

Yard gravel drying
Transparent plastic drying: 45° slope with holes each 10 cm2
Black plastic drying: 45° slope with holes each 10 cm2
Structure (wooden sticks, wire and net plastic) drying
Regular DOV
DOV with CO3K2 (8%) + olive oil emulsion (4%)

2.3 Variables measured

The variables measured in a visual analysis were: color uniformity, size uniformity, substandard percentage, spots presence, discoloration, mold presence, insect presence, damage raisin percentage, crystallization percentage, caramelization percentage, strange materials percentage, out of range, wrinkle uniformity, shape uniformity, taste, skin perception and seed perception (seminal trace). The amount of raisins in 100 g, length and wide were also measure. A group of agronomy engineering students were organized. Scales, rulers, magnifying glass were used along the measurement. Moisture percentage and ochratoxin A content were measured in a certificated ISO 17025 laboratory. Descriptive statistics and cluster analysis were calculated with Infostat program. Also Excel 365 were used.

3 Results

In general (all samples), the mean values for defects variables such as spots, crystallization, caramelization, discoloration, browning, mold presence, damaged, strange materials, insect presence is 0.43% (caramelization) to 6.37% (discoloration). Cristalazation and caramelization represent 2.89%. Other kinds of defects as out of range, browning, shape uniformity and wrinkles all of them together represent 18.26%. Shape uniformity showed the main value from all these variables (5.84%). Capstems and strange materials are 3% each of them. The amount of raisins in 100 g has 156 raisins between the minimum and the maximum value.

Table 1. Descriptive statistics for raisin defect made by different drying methods.

	N	Minimum	Maximum	Average	Standard deviation
Spots %	32	0.00	19.00	2.84	4.21
Out of range %	32	0.00	14.00	5.68	3.61
Capstems %	32	0.00	10.00	2.50	2.75
Crystallization %	32	0.00	12.00	2.46	3.13
Caramelization %	32	0.00	5.00	0.43	0.98
Discoloration %	32	0.00	20.00	6.37	4.41
Mold %	32	0.00	5.00	1.09	1.44
Damage %	32	0.00	10.00	2.71	2.65
Strange materials %	32	0.00	7.00	0.84	1.58
Browning %	32	0.00	8.00	1.84	2.11
Shape uniformity %	32	0.00	17.00	5.84	515
Wrinkle uniformity %	32	0.00	15.00	4.90	4.42
100 g amount raisins	32	84.00	240.00	143.28	31.01
Lenght (mm)	32	13.00	25.00	17.37	3.27
Wide (mm)	32	8.00	16.00	11.40	1.94
Insects %	32	0.00	11.00	1.93	3.02

N=number of samples

When the drying methods are compared, raisins from the drying yard (gravel) present 47.5%; 47.9% and 41.1% more capstems than raisins from DOV, structure or plastic drying yard. The highest crystallization and browning levels are on gravel drying yard. The amount of raisins in 100 g has a 19.98 raisins range different between methods. DOV raisins have the lowest wide value. Gravel and plastic drying yard methods have the most irregular wrinkle percentage and DOV raisins have the lowest value (Table 2). The substandard raisin variable percentage show no differences between drying methods (Table 4). But, a cluster analysis (figure 1), with all the quality variables, classified gravel drying yard as similar as plastic drying yard and DOV as similar as structure drying method.

Table 2. Defect percentage found on the samples classified by raisin production method for 32 samples.

Defects	Method	Modal value	Defects	Method	Modal value
Capstems %	DOV	1.40	Wide (mm)	DOV	9,86
	Structure	1.28		Structure	11,73
	Plastic*	1.57		Plastic*	11,87
	Gravel	2.67		Gravel	12,60
Crystallization %	DOV	0.95	Length (mm)	DOV	14,79
	Structure	1.67		Structure	17,34
	Plastic*	1.86		Plastic*	19,00
	Gravel	1.92		Gravel	18,07
Browning %	DOV	0.33	Wrinkle %	DOV	2,22
	Structure	0.56		Structure	4,57
	Plastic*	1.04		Plastic*	6,33
	Gravel	1.67		Gravel	6,42
100 g raisin amount	DOV	152.48	Caramelization %	Gravel	0,80
	Structure	137.63			
	Plastic*	132.50	Strange matherials %	Plastic[(1)]	0,61
	Gravel	141.43			

[(1)] For this analysis the only raisins sample taken came from black plastic drying method.

The ochratoxin A average shows gravel drying system and structure are associated to the highest content (table 3). About moisture variable, structure drying method has the highest percentage for the same drying time period (table 3). The ochratoxin A variance analysis shows no difference between treatments (table 4).

Table 3. Ochratoxin A and moisture percentage average analysis for four drying methods. Number of samples (n) = 8. Two each replicate.

Method	Ochratoxin A average	Moisture average
DOV	1.03	10.58
Structure drying	2.28	17.22
Black plastic drying	1.28	11.75

Yard gravel drying	3.29	12.85
Transparent plastic drying	1.23	No value

Table 4. Variance analysis for Ochratoxin A and substandard in four drying methods. Ppb = part per billion.

Variable	p-valor
Ochratoxin A content ppb	0.251
Substandard %	0.631

*P<0.05

The organoleptic analysis let us know black plastic drying method has the worst values about shape homogeneity, flavor, color and general grade. In the other hand, DOV system present the best grade by the same aspects. Raisins made by structure present the better flavor (figure 2).

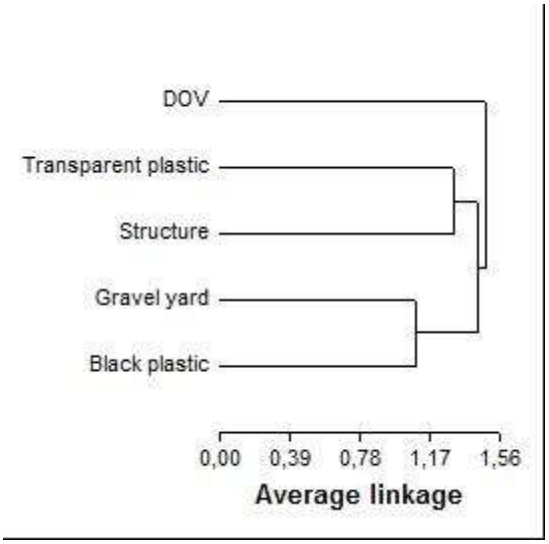

Figure 1. Cluster analysis for raisin grape production methods for 32 samples.

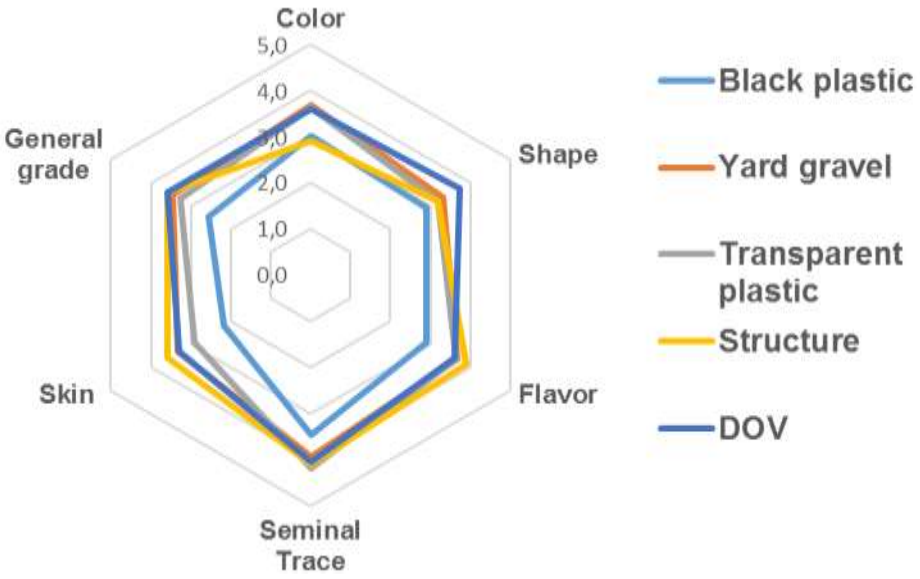

Figure 2. Organoleptic analysis for flavor, skin perception, color, seed perception, shape regularity and general grade.

4 Discussion

One of the most important aspect in quality raisin in the moisture percentage. In DOV raisin regular values are 14% - 16% depending on the variety (Christensen, 2000). Nevertheless, in San Juan DOV raisin shows a moisture content between 9% to 12% in comparison to drying gravel yard raisin between 10% to 14% (Espindola et al, 2017). This study shows moisture values between 10.58% (DOV) and 17.22% (structure). DOV is associated with a higher drying time and structure method needs more time than traditional drying system (gravel) but less than DOV system. Large berries make large raisins that grade higher as B or better category (Christensen, 2000) Winkler indicated weight each 100 berries for 15% moisture and 21 °Brix from 35.6 g to 38.2 g. Flame Seedless raisin in San Juan shows values for 21° Brix and 14% moisture and 65 to 75 g each 100 raisins bonded to 14.79 mm - 19 mm length and 9.86 – 12.6 mm wide. The more fruit maturity the better quality and less substandard percentage (Christensen, 2000; Fidelibus, 2007; Giuseppina et al, 2012). All the methods here compared did not show any difference what means the sugar content has a bigger influence in quality than the raisin production method. The grades B and better (USDA, 2016) are associated with 0.33 g/raisin and substandard raisins with 0.12 g/raisin and there is no correlation between ° Brix of fresh grape and raisin weight (Christensen, 2000; Fidelibus et al, 2008). Flame Seedless made by DOV system has 0.65 g/raisin and drying gravel yard system 0.7 g/raisin. This work indicated substandard values from 6.4% to 10%. Fidelibus et al (2008), indicated values for substandard raisin lower than 4.3%, but the most important influence on this variable is the year weather conditions. Ochratoxin A content should be lower than 10 ppb (Espíndola, et al 2017). The raisin production method does not generate different about ochratoxin A content in raisins, but raisin made by gravel drying yard method have the highest content. DOV raisin have shown better qualities grade about sweet, wrinkle appearance and brown appearance in Fiesta and Selma Pete with higher sugar content and values from 3 to 7 in a maximum grade from 0 to 10. Flame Seedless DOV raisin showed the better grades about color, flavor, shape and skin. Plastic drying tarp raisin present the worst quality in the aspect mentioned. Grade defects limiting percentage for damage, mold, and uncured berries is 5%, but strange

materials or fermentation have 0% tolerance (Christensen, 2000). About the first defects group the values in San Juan are lower than the ones are mentioned but about strange materials the values are over 0% (0.84%).

6 Conclusion

All the defects studied present values lower than 5% what implies San Juan Flame Seedless raisins could obtain a good quality grade, but the value for strange material is out of the limit. Shape uniformity, out of range and discoloration are the higher defects founds into the samples. The weight and size is higher than the common standard values. DOV raisin shows the lower values abut defects compared with structure, gravel and plastic drying methods and gravel drying method is linked with the highest amount of ochratoxin A in all samples. DOV and structure drying method are similar about raisin quality characters. The same situation happened for gravel and plastic drying methodsboth of them associated with the higher substandard raisin level. Structure drying method needs more time for getting the same moisture content than gravel drying method or plastic drying method. DOV and structure drying method produce the better organoleptic quality about color, flavor and appearance.

7 References

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