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Research Note

Partial Characterization of *Vitis vinifera* grapes var. Ancellotta

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Freezing point depression and some physical characteristics of Vitis vinifera *grapes var. Ancellotta were investigated after two different post-harvest treatments of samples (slow air-freezing at –18°C and storage at 2°C in N_2 atmosphere). The measured acinus mean weight and diameter, relative weight composition of a cluster and total soluble solids content differed slightly from those of fresh grapes. The observed freezing point depression values for treated grapes and grape juice were smaller than the respective calculated data. The differences were characterized by alteration in soluble solids composition due to the treatments, which decreased solute–solvent interactions.*

Introduction

Fresh foods can be conveniently preserved by freezing. The overall quality of frozen products is greatly influenced by freezing time, which depends on the dimensions (especially the thickness), shape and freezing point depression (FPD) of the product (1). An accurate knowledge of product FPD and physical dimensions is needed for calculating refrigeration requirements, freezing equipment design and the reliable analysis of a food freezing or thawing process (2).

Foods are complex composition systems, containing dissolved solutes and suspensions of nonsoluble components. Although the water content of most foods is high, the freezing point of water is lowered by dissolved substances in the solution, which cause the behaviour of foods to deviate from the ideal solutions laws (3). This lowering of the freezing point (FPD) is related to solute composition. In fact, the behaviour of FPD indicates the properties of solutes in the solution, which reflects the overall effect of these solutes (4). Polley *et al.* (5) calculated the FPD of *Vitis vinifera* grapes (19.30 °Brix) to be –3.2°C. Several researches developed semi-empirical equations to estimate FPD of fresh fruit juices according to soluble solids content, effective molecular weight and solute–water interactions (2–4), water activity (6) and enthalpy and specific heat (7–10), but there is a lack of information on experimental data for grape and grape juice. The present work was conducted to determine physical dimensions of acinus and cluster, total soluble solids contents and FPD of treated juice and fruit, and then relate soluble solids to the FPD, and finally to evaluate the effects of two different storage conditions of fresh grapes on the characteristics cited above.

Materials and Methods

Vitis vinifera grapes var. Ancellotta were purchased directly from agriculturists of eight locations around Reggio Emilia zone (North Italy). Grapes were harvested in October 1992 and September 1993, at industrial maturation state. All eight vine orchards were cultivated in plan (20 m above sea level) and homogeneous land, undergoing normal and similar climatic variations (temperature and relative humidity ranged from 15 to 30°C and from 40 to 60% respectively, from July to October, under normal levels of rain). Grapes from vintage 1992 were slowly frozen in air at –18°C right after harvesting and then held at this temperature for 3 mo while the second vintage was stored at 2°C in N_2 atmosphere for 3 mo.

Treated and freshly harvested grapes were analysed for °Brix by refractometer. The °Brix value represents mass fraction of all the soluble solids in the juice (2).

Samples of pulp (juice model system) and pulp plus skin (grape model system) were previously homogenized. FPD of these samples were determined by Beckman differential thermometer as described by Chen (3), but adopting ethylene glycol (Carlo Erba, Milan, Italy) kept constantly at –10°C instead of propylene glycol at –30°C as refrigerant bath. The samples were constantly agitated during cooling, in order to reduce temperature gradients in the bulk of the samples and thus to facilitate the determination of

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the exact temperature at which ice crystals began to form.

Twelve samples of 15 units each were taken to determine acinus mean weight using an analytical balance (Gilbertini E42, Milan, Italy); for the mean diameter, 10 samples of 15 units each were measured with a sliding calliper (Mitutoyo, Milan, Italy). The mean value of each sample is the median, and the global mean (mean of sample means) is the arithmetic one. Relative weight composition of cluster was the arithmetic mean of eight determinations.

The *t*-test was used to estimate 95% confidence intervals of means of all determinations.

Results and Discussion

Table 1 Mean weight and diameter of acinus samples

Sample	Weight (mg)[a]			Diameter (mm)[b]		
	$\bar{x}$	s_x	95%c.i.[c]	$\bar{x}$	s_x	95%c.i.[c]
Vintage 1992/93	1262	71	45	12.1	0.2	0.1

[a] 12 samples of 15 units each; grapes from vintage 1992.
[b] 10 samples of 15 units each; grapes from vintage 1992 and 1993.
[c] 95% confidence interval.

Cosmo and Polsinelli (11) reported for fresh Ancellotta grapes, at industrial maturation state, a mean weight of 1.20 g and a mean diameter of 12.50 mm. The present study found similar values for post-harvest-treated grapes (**Table 1**). Additionally, three major groups of weight and diameter were observed, as follows: group one (0.6 to 1.0 g and 8.0 to 10.0 mm). represented 19% of total tested samples; group two (1.0 to 1.3 g and 10.0 to 12.5 mm) 37% and group three (1.3 to 1.6 g and 12.50 to 15.00 mm) 34%. Values below (2%) and above (8%) this range completed 100% of total tested samples.

Table 2 Relative weight composition of cluster

Parameter	Unit	acinus	stem	cluster
Mean	g/100 g	95.28	4.72	100.00
Standard deviation	g/100 g	0.69	0.69	—
95% confidence interval	g/100 g	0.58	0.58	—

Arithmetic mean of eight determinations; clusters from vintage 1992.

Table 2 shows the relative weight composition of a cluster. These values are higher than those of Cosmo and Polsinelli (11) (2.7 g of stem per 100 g of cluster) but are similar to the data of Pallotta *et al.* (12) (2.5 to 5.0 g of stem per 100 g of cluster) for fresh grapes at industrial maturation state.

No significative differences ($P < 0.05$) were observed in total soluble solids contents of fresh and treated grapes, either experimentally or compared to published data (**Table 3**). The results of experimental and calculated FPD data for treated and fresh grapes and grape juice are presented in **Table 4**. The experimental FPD data for treated grapes were lower than those calculated for fresh and treated grape juice from semi-empirical equations (4).

Table 3 Published and experimental data of total soluble solids contents for fresh and treated grapes

Parameter	Unit	Experimental data		Published data
		treated grapes[a]	fresh grapes[b]	fresh grapes[c]
Mean	°Brix	19.38	19.24	19.30
Standard deviation	°Brix	2.88	2.69	—
95% confidence interval	°Brix	1.07	0.98	—

[a] Arithmetic mean of 30 determinations; grapes from vintage 1992 and 1993.
[b] Arithmetic mean of 10 determinations; grapes from vintage 1992 and 1993.
[c] Polley *et al.* (5).

The effective molecular weight of treated grape juice was 240.53, as estimated by Chen's FPD modified equation for real solutions (4):

$$M_S = K \cdot X_S / (1 - X_S - b \cdot X_S) \cdot \text{FPD} \qquad \text{Eqn [1]}$$

where M_s is the effective molecular weight of constituent solutes; X_s is mass fraction of solutes; K is the Van't Hoof's constant (K = 1860°C.g/(g.mol)); b is the mass of bound water per unit mass of solutes (b = –0.16 for 19 to 20 °Brix grape juice). Fresh grape juice has been reported to have an effective molecular weight between 168.89 (4) and 184 (2), when grapes were harvested at industrial maturation state.

The observed differences in FPD values and effective molecular weight of treated and fresh grapes could be attributed to an alteration in solute composition, as no changes in soluble solids content were observed. When freshly harvested grapes (vintage 1992) were slowly frozen in air, O_2 absorption and respiration (normal metabolism) were inactivated and abnormal metabolic activities took place shortly before inactivation (1), which did not alter soluble solids content, but could have altered solutes composition. According to Arfelli (13), anaerobic metabolism of grapes leads to demolition of sugars and acids into ethanol, glycerine and aromatic compounds (acetates and esters), without changing soluble solids content.

In fact, the FPD is connected with the coefficient of solute–water interaction (the theory of water binding property of solute molecules), which greatly depends on solute composition (2, 3). Therefore, variations of the FPD can be expected due to differences in solute composition (2–4).

This study shows that preserving freshly harvested grapes by freezing or chilling in N_2 atmosphere does not alter physical dimensions or total soluble solids content. Therefore, the values obtained are reliable data that can be applied to fresh grapes, and both storage conditions are suitable techniques to preserve fresh grapes that are destined for *in natura* consumption. However, freezing fresh grapes slowly in air

Table 4 A comparison of experimental and calculated FPD data for treated and fresh grapes and grape juice

Parameter	Unit	Experimental data		Calculated data			
		treated grapes[a]	treated grape juice[b]	fresh grape juice[c]	treated grape juice[c]	fresh grape juice[d]	treated grape juice[d]
Mean	°C	–2.00	–1.79	–2.62	–2.64	–2.52	–2.55
Standard deviation	°C	0.06	0.02	—	—	—	—
95% confidence interval	°C	0.10	0.02	—	—	—	—

[a] Arithmetic mean of four determinations; grapes from vintage 1992.
[b] Arithmetic mean of five determinations; grapes from vintage 1992.
[c] Calculated from the following equation obtained by Chen (4): FPD= $-(C_1 X_s + C_2 X_s^2$, where X_s is mass fraction of solutes; C_1 and C_2 are empirical constants for grape juice (C_1=11.056 °C; C_2=13.333 °C).
[d] Calculated from equation [1] using b= –0.16 and M=168.69 (4).

caused a decrease in the FPD, probably due to alteration in solute composition. A decrease in the depression of the freezing point is of interest in grape freezing or thawing, as a smaller thermal load is needed, but it is important to underline that changes in solute composition can interfere, either positively or negatively, in grape-processing technology and in final product quality.

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