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SANGUIS JOVIS
ALTA SCUOLA DEL SANGIOVESE

IV Edizione

SUMMER SCHOOL
SANGUIS JOVIS

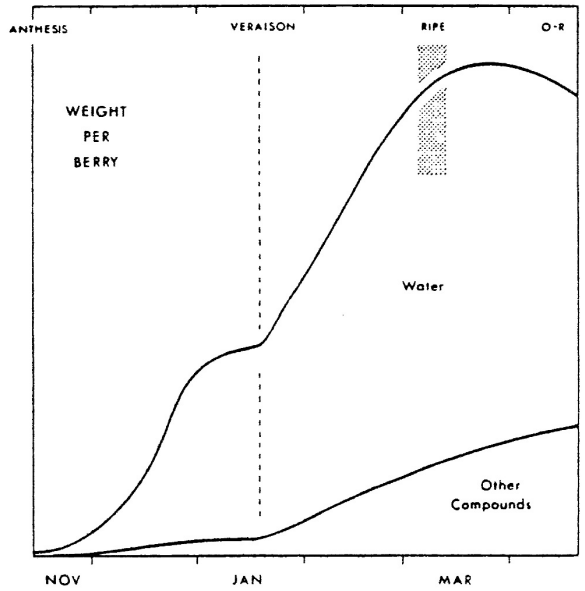
MATURAZIONE E MATURITA' DEL SANGIOVESE: LA RICERCA DI UN EQUILIBRIO TRA VITICOLTURA ED ENOLOGIA

OCRA- Officine Creative dell'Abitare
Montalcino, 20- 24 settembre 2021

Aspetti fisiologici e biochimici dei processi di sviluppo e maturazione delle bacche

Osvaldo Failla - UNIMI


ALTRO



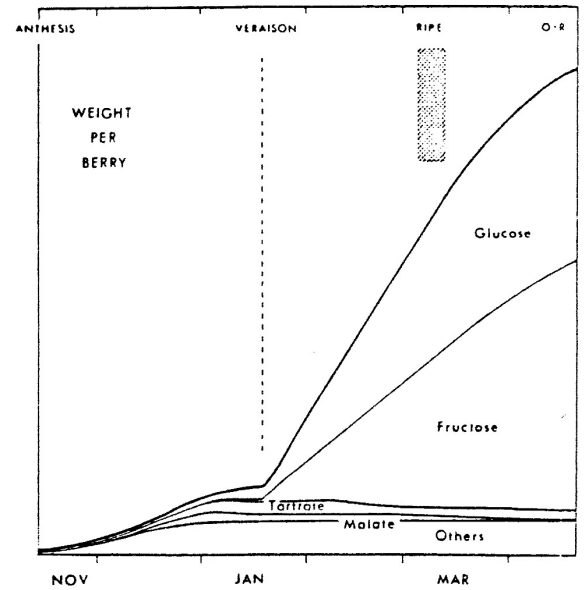


Fig. 23 (top). Generalized curves of water and dry matter in a grape berry from anthesis to ripeness (8).

Fig. 24 (bottom). Generalized curves showing the types of changes in the amounts of the major components of the dry matter during berry development (8).

ORIGINAL RESEARCH ARTICLES

First quantitative assessment of growth, sugar accumulation and malate breakdown in a single ripening berry

Rezk Shahood, Laurent Torregrosa, Stefania Savoi, Charles Romieu

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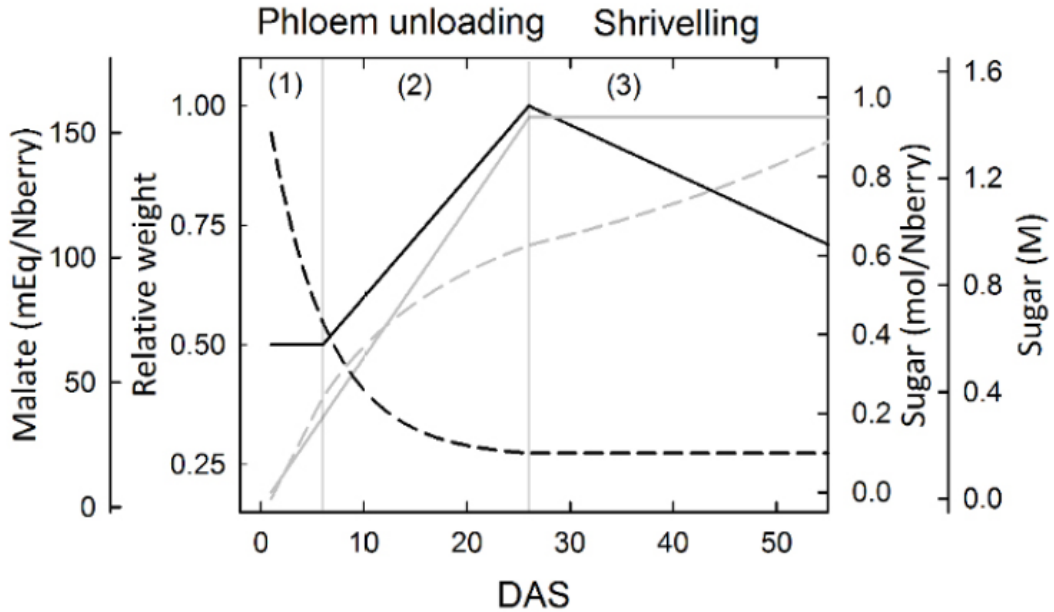


FIGURE 9. Minimal model of berry ripening.

DAS: Days After Softening. Phase (1): full activation of sugar loading & malate breakdown, no expansion. Phase (2): full-rate sugar & water loading; (2a) malate breakdown (2b) completion of malate breakdown. Phase (3): water and sugar import blocked, evaporation. Sugar content per berry (grey line), sugar concentration (dashed grey line), growth (black line), and malate content per berry (dashed black line). Results were normalised for the number of berries that weighed 1 kg (Nberry) at the completion of phloem unloading (phase 2-phase 3 transition).

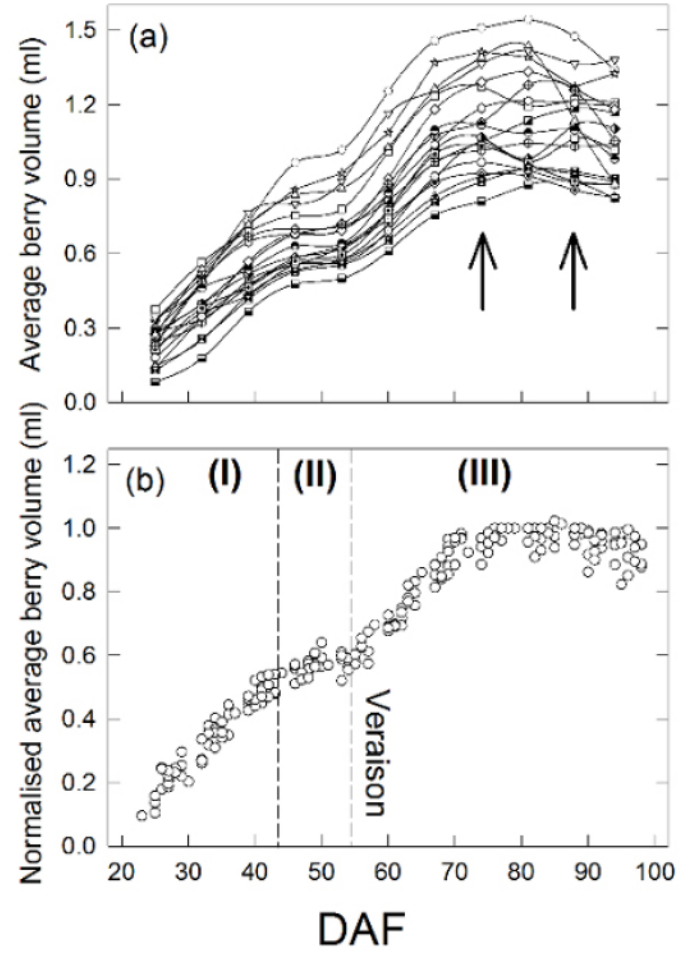


FIGURE 1. Average berry growth in 20 Meunier clusters.

(a) Each curve corresponds to one cluster.

(b) Relative growth following normalisation of the maximal average berry volume and re-synchronisation of the onsets of the second growth period at 55 days after flowering (DAF). Normalised average berry volume: $V/(V_{max} \times Nb)$, where V represents cluster volume, V_{max} represents maximum cluster volume, and Nb represents number of berries per cluster. Arrows correspond to the maximal and minimal time needed to reach maximal volume after mean flowering date (2014-05-15).

(I) Green phase, (II) Lag phase, (III) Ripening phase.

Gambetta et al. - 2020 - The physiology of drought stress in grapevine Towards an integrative definition of drought tolerance – Journal of Experimental Botany, Vol. 71, No. 16 pp. 4658–4676

Gouthu *et al*. 2014

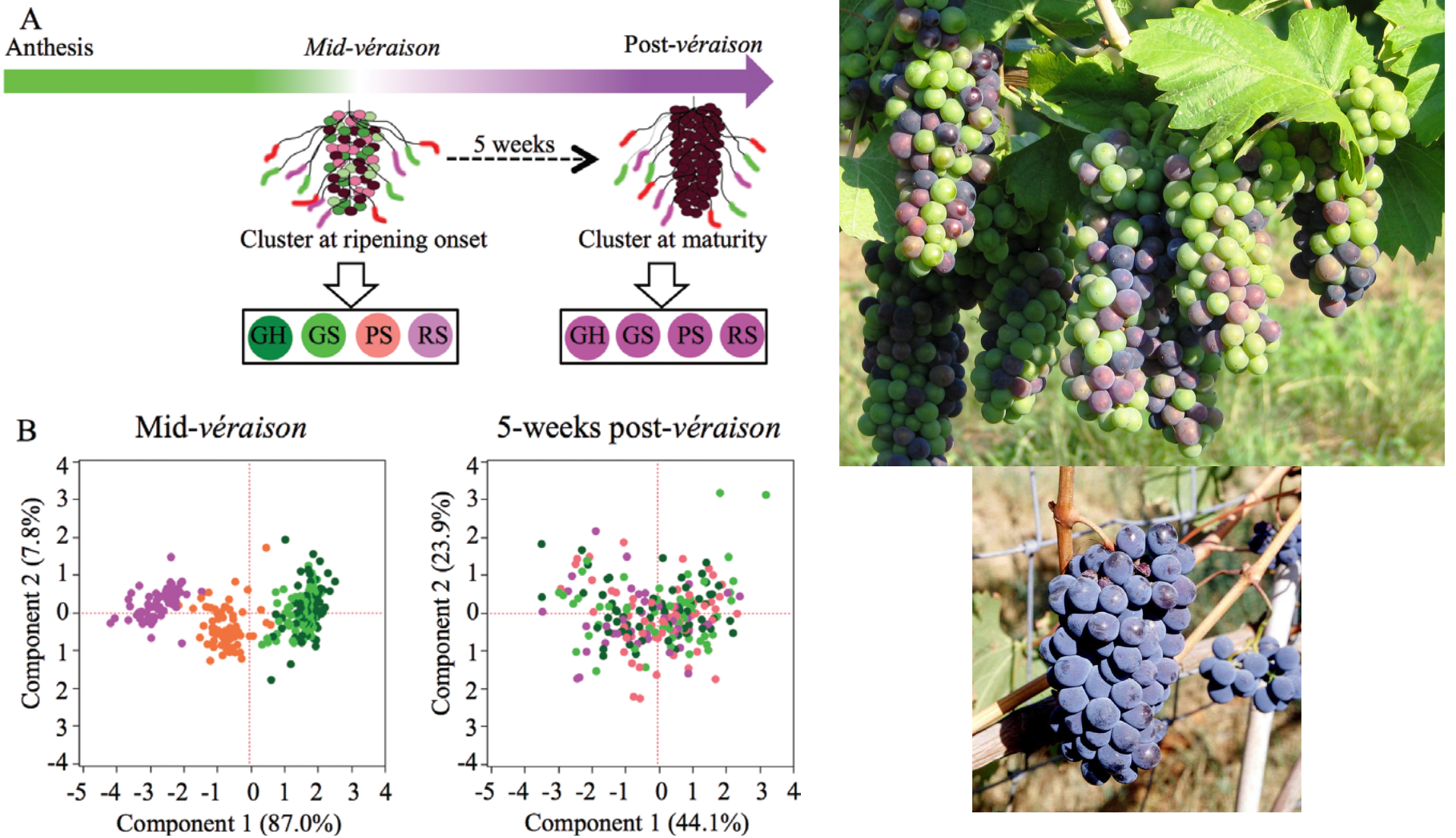


Fig. 1. Ripening state variation among berries within a cluster at ripening onset and uniform ripeness upon maturity. (A) Schematic representation of cluster ripening and sampling of ripening classes Green Hard (GH), Green Soft (GS), Pink Soft (PS), and Red Soft (RS) at mid-veraison (V) and at 5 weeks post-veraison (PostV). (B) Principal component analyses showing ripening differences between GH, GS, PS, and RS berries at V and PostV. Colour [L (lightness), h (hue angle), and C (chroma)], and total soluble solid content (°Brix) of individual berries were used as continuous variables. The number of berries (*n*) is 75 for each class in the V plot; and 67, 61, 64, and 47 berries for GH, GS, PS, and RS, respectively, for the PostV plot. Dots representing GH, GS,PS or RS berries are clustered from right to left, respectively, in the mid-veraison plot. Loading plot data of the PCAs are given in Supplementary Table S6 at *JXB* online.

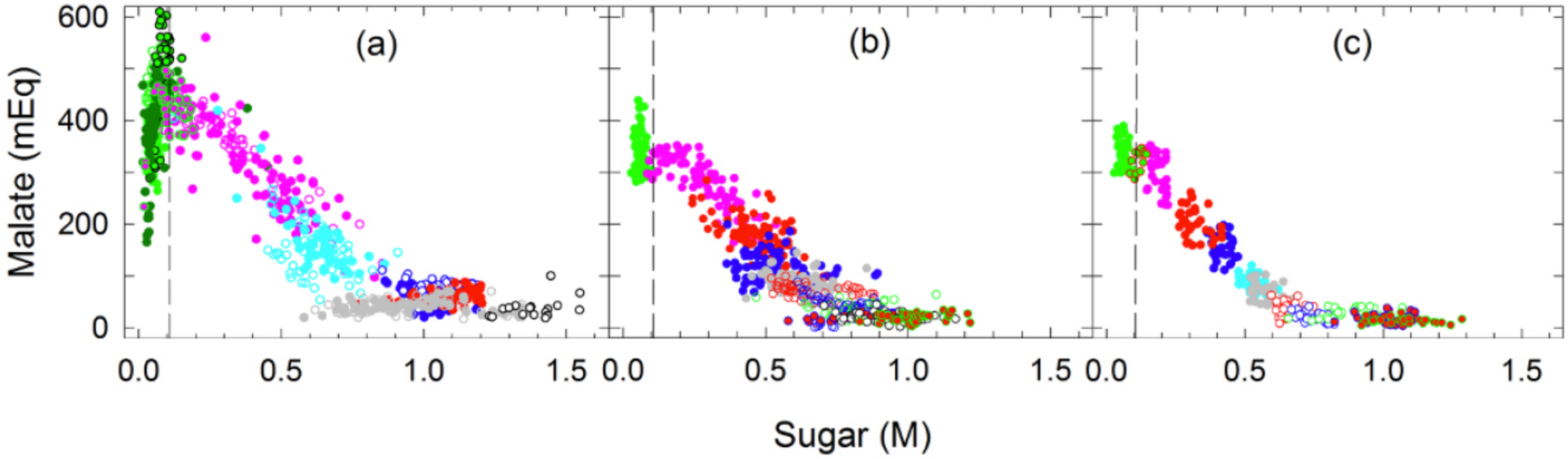


FIGURE 4. Heterogeneity in malate and sugar concentrations in individual berries according to the sampling method.

Softening is indicated by dotted line.

(a) Meunier berries from clusters-based sampling. Cluster sampling date: -10 DAV (3 clusters: green, dark-green and open-green circles), 0 DAV (2 clusters: pink and open pink circles), 10 DAV (2 clusters: cyan and open-cyan circles), 20 DAV (2 clusters: blue and open blue circles), 30 DAV (1 cluster: red circles) and 40 DAV (2 clusters: grey and open grey circles). DAV: days after veraison (50 % soft berries).

(b) Syrah berries, random sampling; each point describes one sampled berry: -10 DAV (green circles), 0 DAV (pink circles), 5 DAV (red circles), 8 DAV (blue circles), 13 DAV (grey circles), 18 DAV (open red circles), 25 DAV (open blue circles), 32 DAV (open green circles), 39 DAV (blue red circles), 46 DAV (open black circles) and 55 DAV (green red circles).

(c) Syrah berries, synchronised (known individual softening date). Each point depicts one sampled berry: -1 day after its own softening date (DAS) (green circles), 0 DAS (pink green circles), 1 DAS (pink circles), 3-5 DAS (red circles), 5-6 DAS (blue circles), 7-8 DAS (cyan circles), 8-11 DAS (grey circles), 16-18 DAS (open red circles), 19-22 DAS (open blue circles), 29-30 DAS (open green circles), 37-38 DAS (blue red circles) and 52-54 DAS (green red circles). Softening dates may vary among berries (not shown).

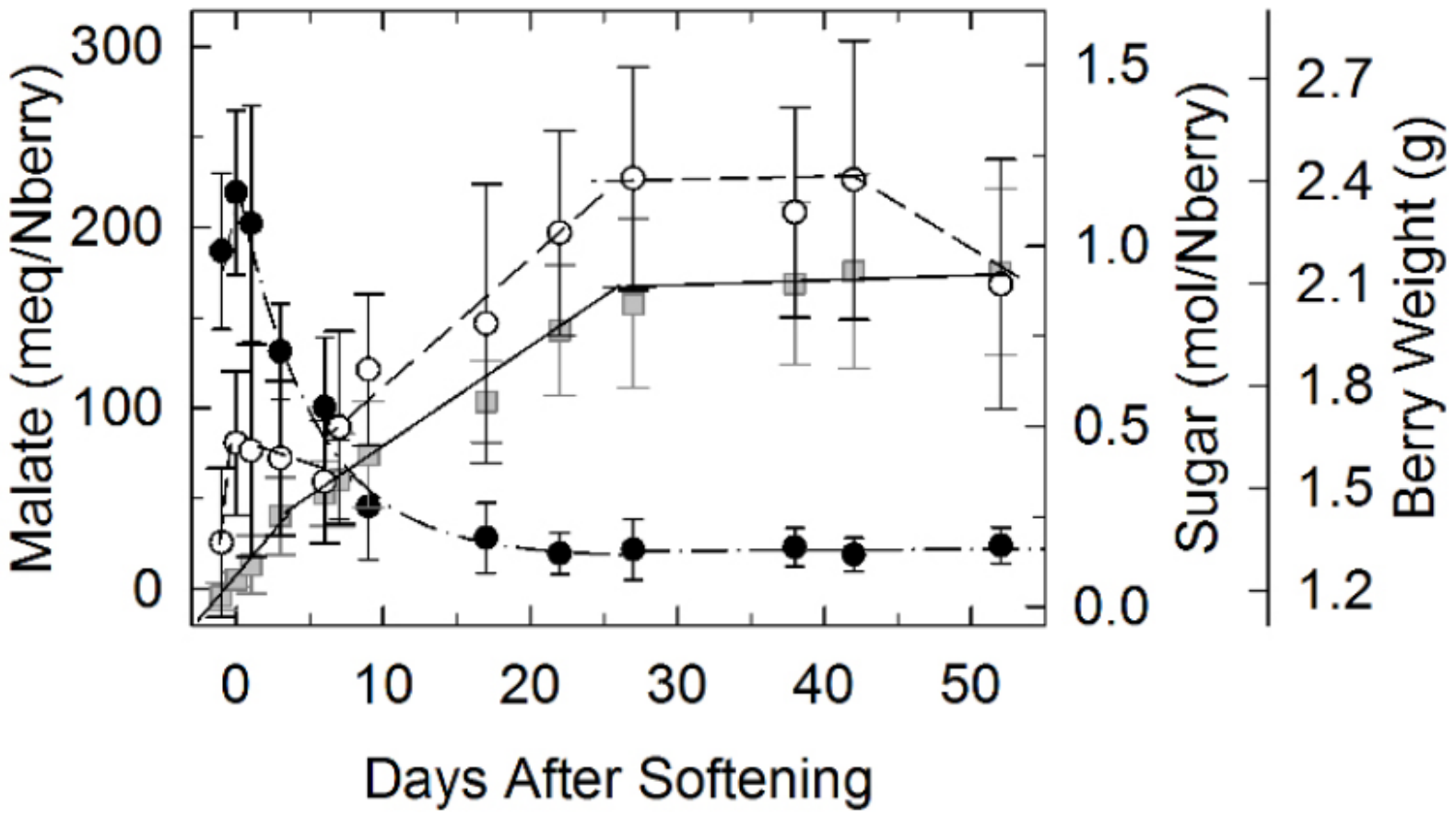
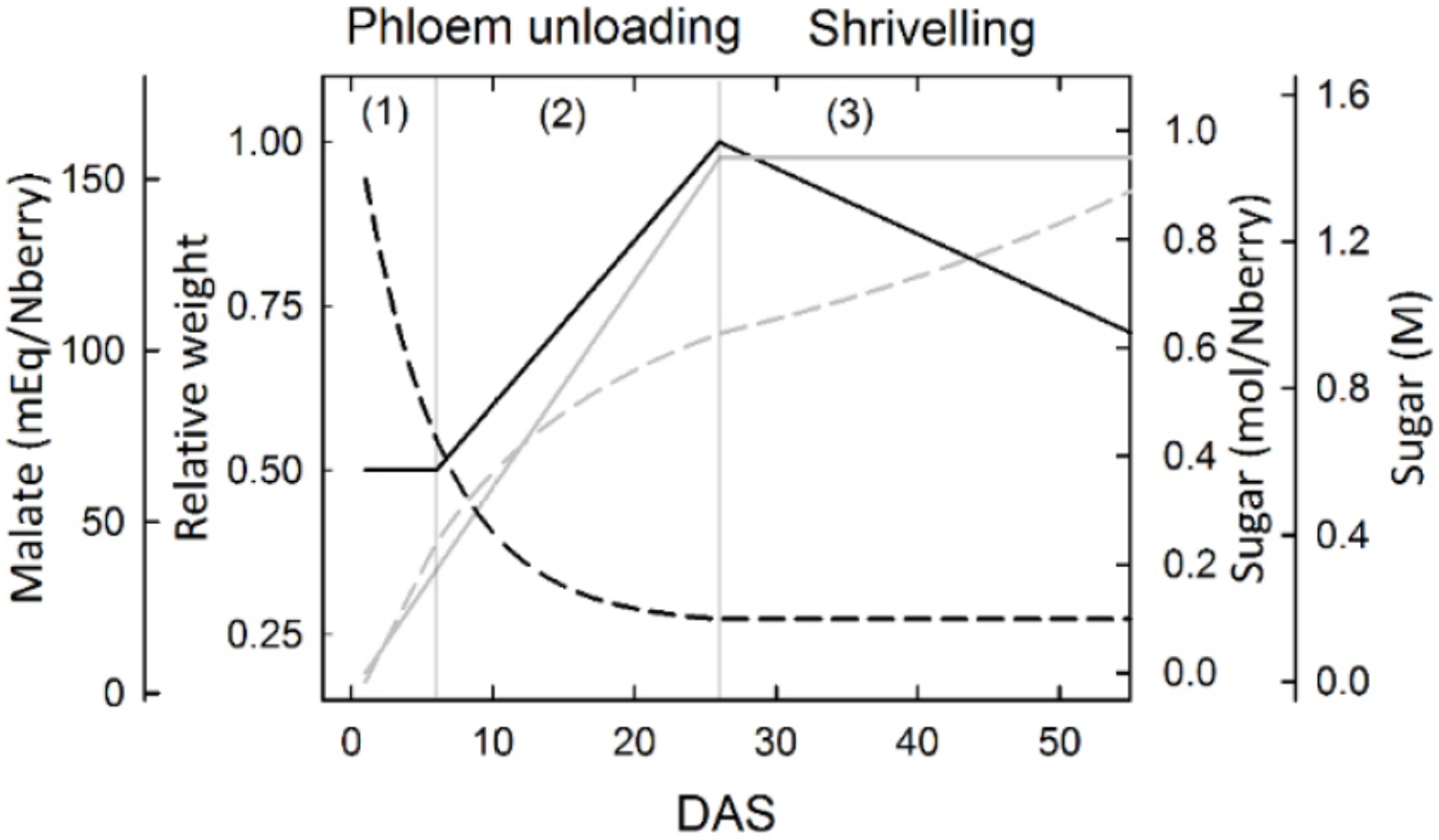


FIGURE 7. Kinetics of malate breakdown (closed circles), sugar loading (grey squares) and berry growth (open circles) in 385 individual Syrah berries (mean ± SD, n = 30) (see Figure 4c).



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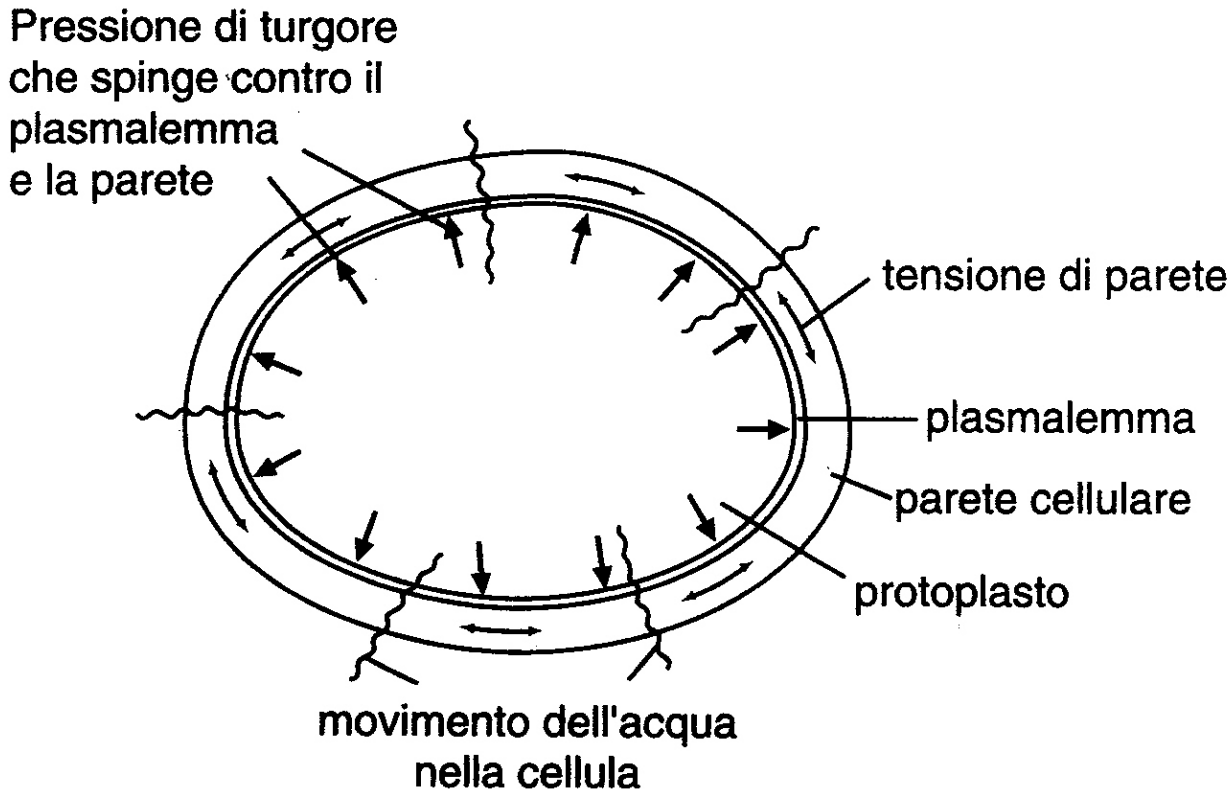
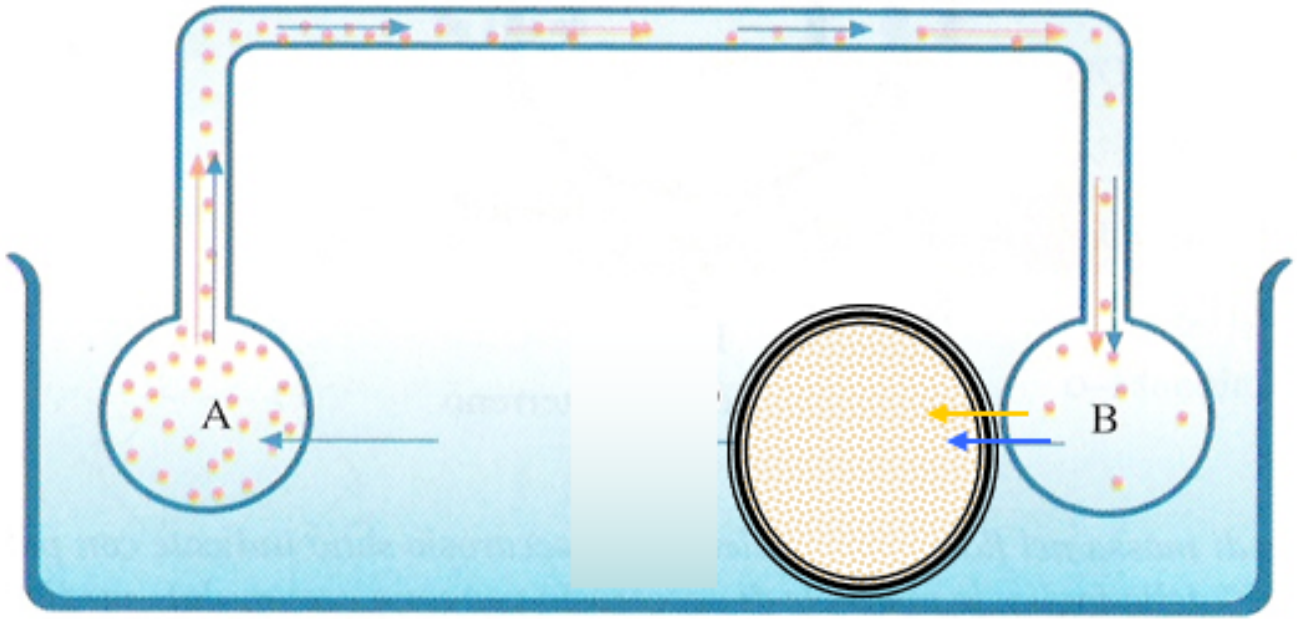


Fig. 11.43. *In una cellula vegetale l'entrata di H_2O controllata dal gradiente osmotico determina la creazione di una pressione positiva (di turgore) che spinge il protoplasto contro la parete. A sua volta questo determina un aumento di tensione nella parete cellulare (stress) e un aumento di turgidità. La pressione di turgore è pertanto la forza motrice che controlla l'estensione in una cellula in crescita. (Da Brett e Waldron, 1989).*



Ψ_s = -1,6 MPa	Ψ_s = -0,50 / -4,00 MPa	Ψ_s = -0,7 MPa
Ψ_p = +0,6 MPa	Ψ_p = +0,05 MPa	Ψ_p = +0,3 MPa
Ψ_w = -1,0 MPa	Ψ_w = -0,45 / -3,95 MPa	Ψ_w = -0,4 MPa

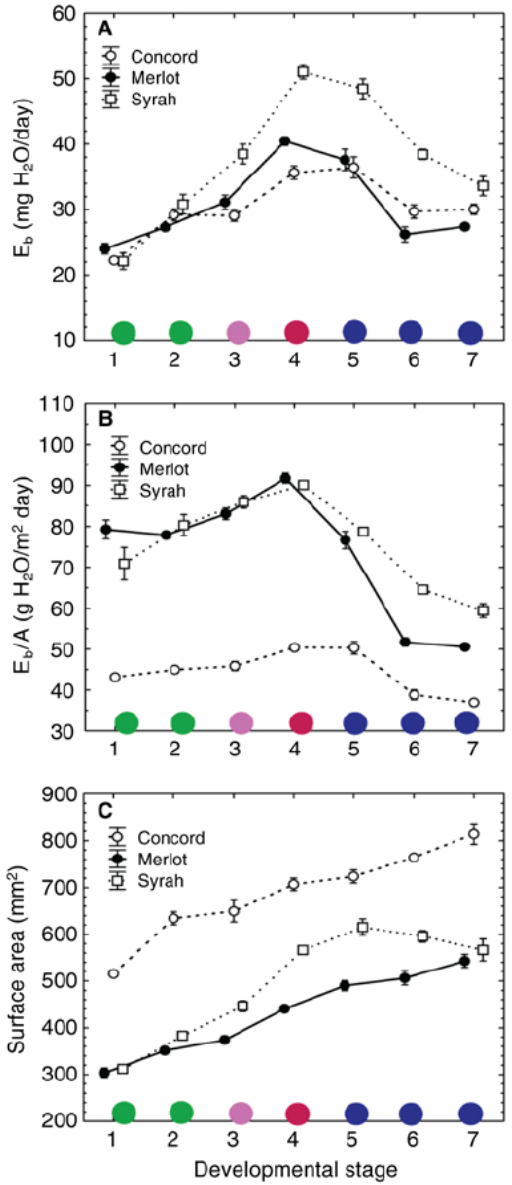


Figure 3 Grape berry (**A**) transpiration rate per berry (E_b), (**B**) transpiration rate per surface area (E_b/A), and (**C**) surface area of Concord, Merlot, and Syrah at successive developmental stages (1 = green hard; 2 = green soft; 3 = blush/pink; 4 = red/purple; 5 = blue; 6 = ripe; 7 = overripe). The color of the circle above the x-axis indicates the color of the berry skin at each stage. Transpiration was measured by weighing detached berries over 48 hr in a controlled environment. Data are means ± SE where SE > symbol size (n ≥ 5, 10 berries per replicate).

Table 2 Cuticular conductance (g_c) of Concord, Merlot, and Syrah grape berries at varying developmental stages. The g_c was calculated as the rate of berry transpiration per surface area divided by the gradient of the mole fraction of water vapor between the ambient air and the berry apoplast (Equation 2). Data are presented as means ± SE (n = 5; 10 berries per replicate). Different upper case letters indicate significant difference among genotypes within each stage; different lower case letters indicate significant difference among stages within each genotype ($p < 0.05$, Fisher's least significant difference test).

			g_c (mmol H_2O/m^2 sec)[a]		
Stage	Code	Phenology	Concord	Merlot	Syrah
Green hard	1	Preveraison	2.2 ± 0.02 C cd	4.0 ± 0.12 A c	3.6 ± 0.20 B d
Green soft	2	Veraison	2.3 ± 0.02 B bc	4.0 ± 0.05 A c	4.1 ± 0.13 A c
Blush/pink	3	Veraison	2.4 ± 0.08 B b	4.3 ± 0.07 A b	4.4 ± 0.10 A b
Red/purple	4	Veraison	2.6 ± 0.06 B a	4.7 ± 0.06 A a	4.7 ± 0.05 A a
Blue	5	Postveraison	2.6 ± 0.08 B a	4.0 ± 0.11 A c	4.1 ± 0.04 A c
Ripe	6	Postveraison	2.1 ± 0.07 C de	2.8 ± 0.05 B d	3.4 ± 0.02 A d
Overripe	7	Postveraison	2.0 ± 0.04 C e	2.7 ± 0.02 B d	3.2 ± 0.09 A e

[a]The unit mmol H_2O/m^2 sec may be converted to cm/hr by multiplying the presented values with 9.45.

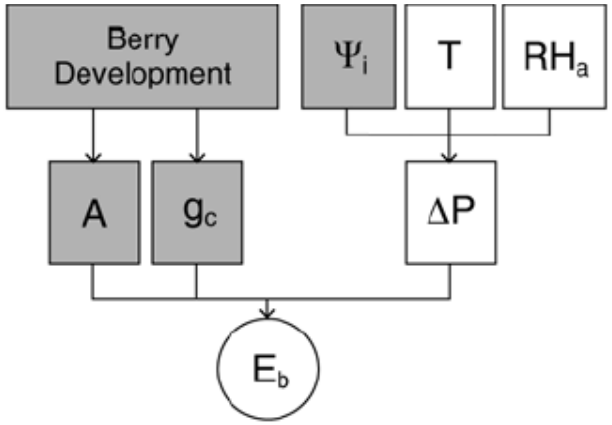


Figure 7 Internal (shaded rectangles) and external (open rectangles) factors that influence the rate of grape berry transpiration (E_b). Berry surface area (A), apoplast water potential (Ψ_i), and cuticular conductance (g_c) change during berry development. Ambient air temperature (T) and relative humidity (RH_a), i.e., vapor pressure deficit, are the main factors determining the driving force (ΔP) for berry transpiration, while the influence of Ψ_i is minor. Consequently, E_b is determined by ΔP, g_c and A.

Zhang, Y., & Keller, M. (2015). Grape Berry Transpiration Is Determined by Vapor Pressure Deficit, Cuticular Conductance, and Berry Size. American Journal of Enology and Viticulture, 4, 454–462. https://doi.org/10.5344/ajev.2015.15038

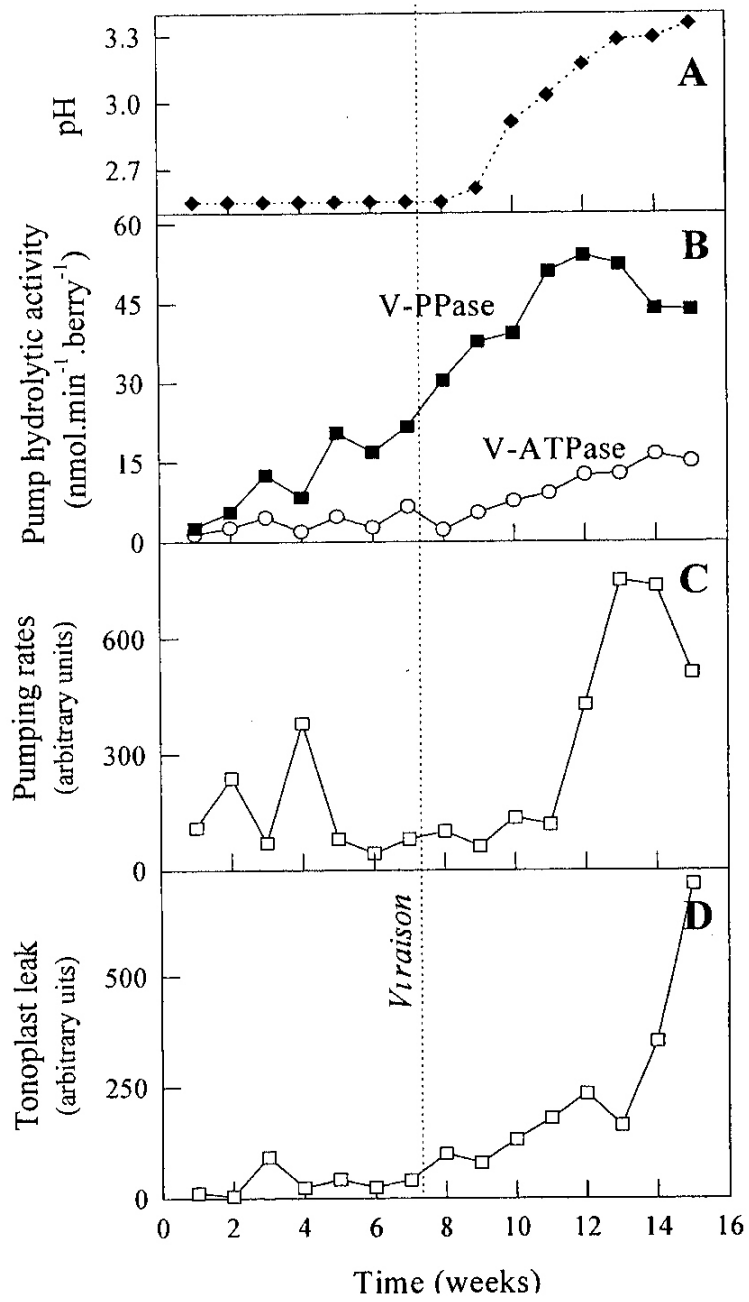


Figure 2.6. Changes in pH (A), hydrolytic activities of vacuolar H^+-pumps (B), H^+ pumping activities (C) and H^+ passive diffusion (D) during grape berry development (from Terrier, 1997).

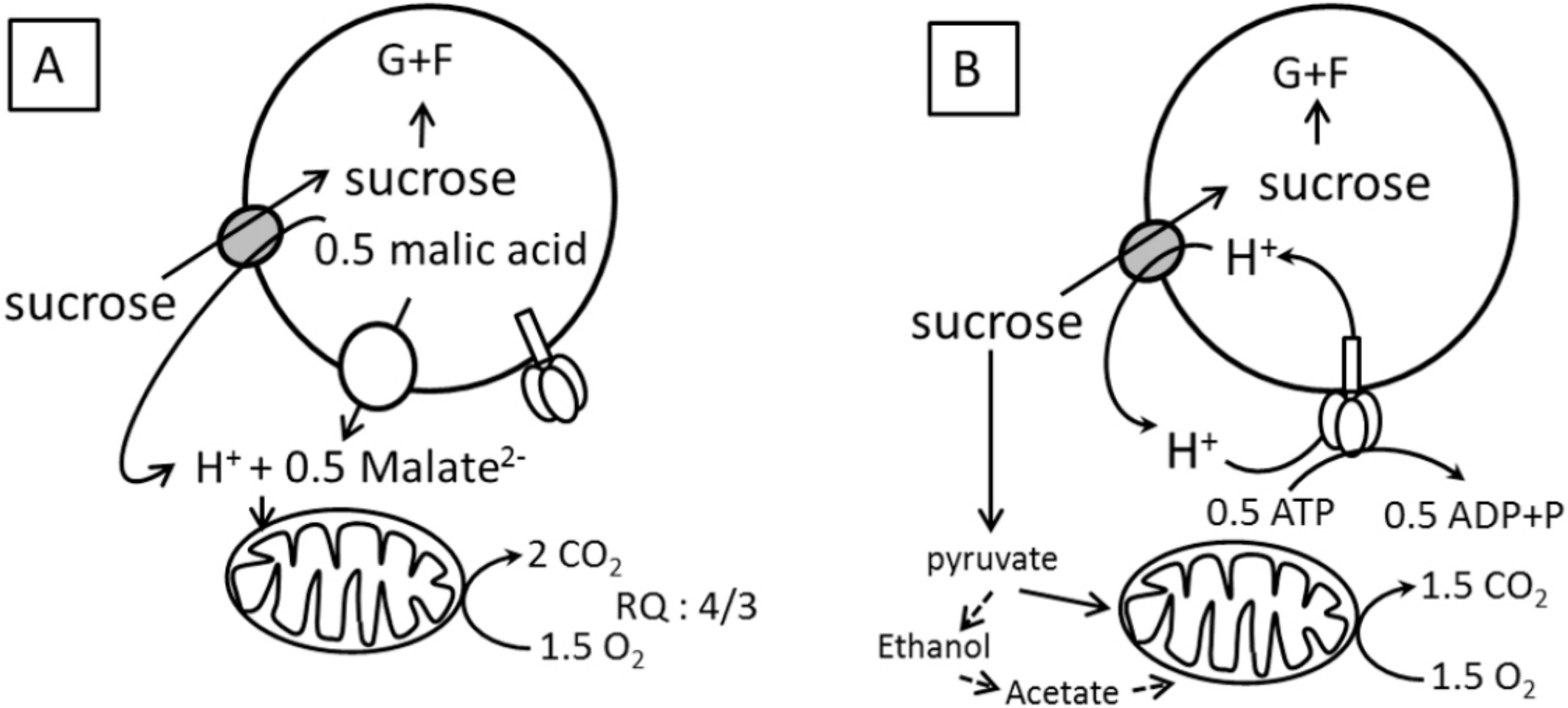


FIGURE 10. Shift in the energisation of sugar transport in the vacuole of ripening berries.

(a) At the onset of ripening, the discharge of vacuolar malate electrically balances a proton/sugar exchange, and malic acid is respired when released into the cytoplasm. This prevents cytoplasmic acidosis. Following the exhaustion of vacuolar malic acid (b), electro-neutralisation requires protons exchanged with sugar to now be pumped back into the vacuole, which consumes ATP. Respiration shifts from malic acid to sugars and aereobic fermentative pathway is induced.

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