ULTRA PREMIUM QUALITY

Processing aids for oil extraction

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Oil production and quality

Processing aids

They must comply with 2 rules:

1. The product modifies the process conditions but does NOT remain in the oil composition

2. The product does NOT impact on oil quality

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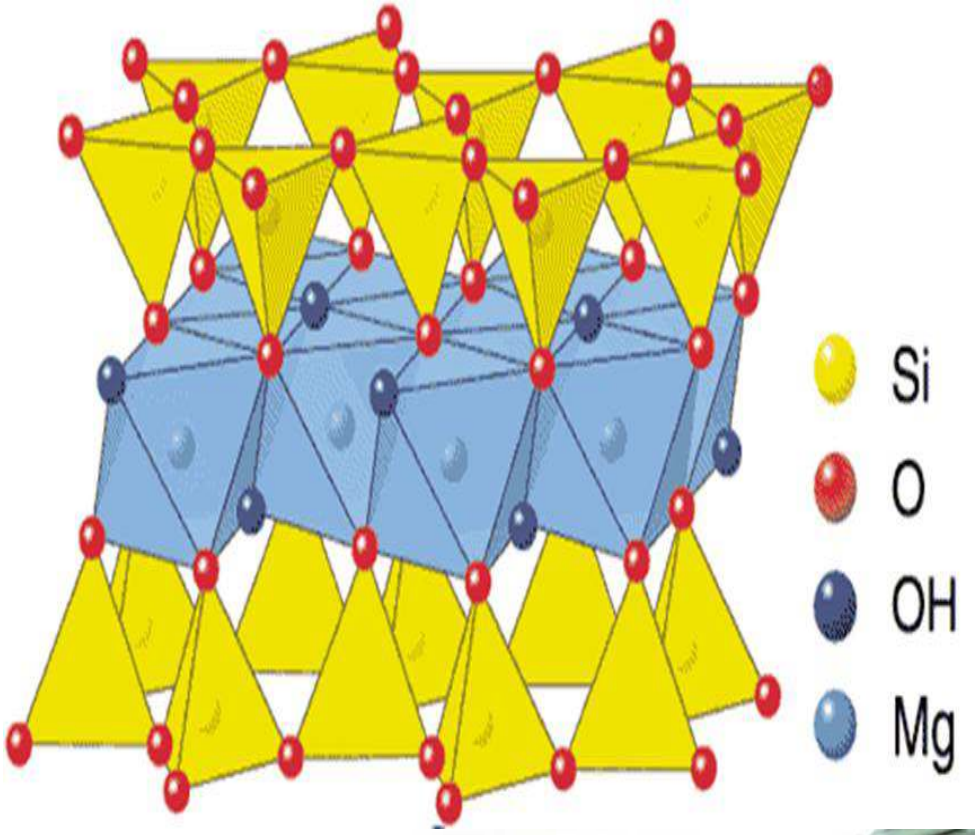
Oil production and quality

Talc & microtalc powder

- ✓ Natural mineral (hydrated magnesium silicate) of laminar structure
- ✓ Provokes aggregation of particles and provides structure to the olive paste in the malaxer
- ✓ It does not allow the paste to stick to the internal walls of the decanter



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Oil production and quality

Microtalc powder

Total Pectins

Table 3. Effect of talc addition on pectin fractions and total pectin content of olive paste after malaxation

	MNT (%)			
	0	0.25	0.5	1
WSP (mg/100 g AIS)	434 ± 59†a*	293 ± 39b	244 ± 51b	261 ± 26b
CSP (mg/100 g AIS)	359 ± 35a	236 ± 11b	220 ± 7b	354 ± 4a
NSP (mg/100 g AIS)	483 ± 61ab	387 ± 55b	348 ± 23b	590 ± 62a
TP (mg/100 g AIS)	1275 ± 83a	915 ± 76b	812 ± 76b	1206 ± 88a

*Different letters within a row mean significant differences ($p < 0.05$) with respect to process step.
†Mean ± SD ($n = 3$).

Decrease in total pectins with talc addition

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Microtalc powder

Cell wall Proteins

Decrease in proteins with talc addition

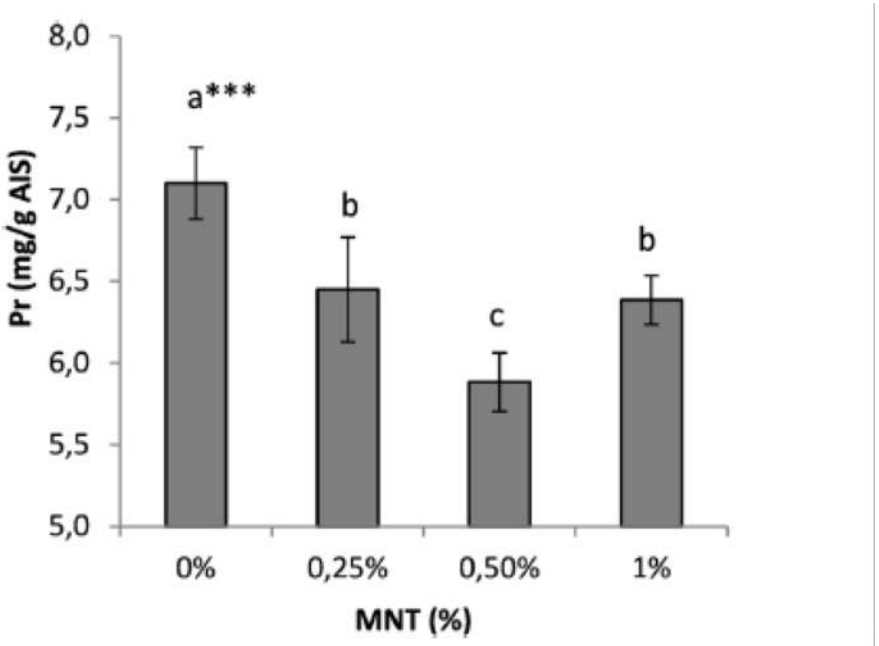

Figure 3. Effect of MNT addition on the cell wall protein content of olive paste during malaxation. Significant differences at *p: 0.05, **p: 0.01; ***p: 0.001.

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Oil production and quality

Talc & microtalc powder

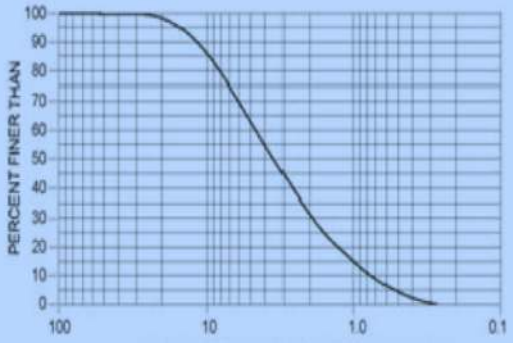
Typical properties

Brightness, GEB	79
Surface Area, m^2/g	12-15
Specific Gravity	2.8
pH, 10% Slurry	8-9
Bulk density gm/cc	0.65-0.85

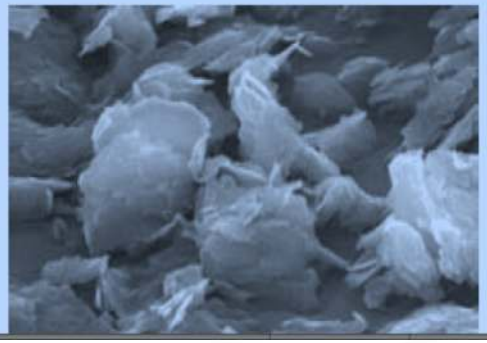
Mineral analysis (by X-ray Diffraction)

Talc, %	94-98
Dolomite, %	1-3
Other, %	1-3

Particle size distribution (by Sedigraph)
Median Diameter: 3.5 microns



Micrograph (by Scanning Electron Microscopy)



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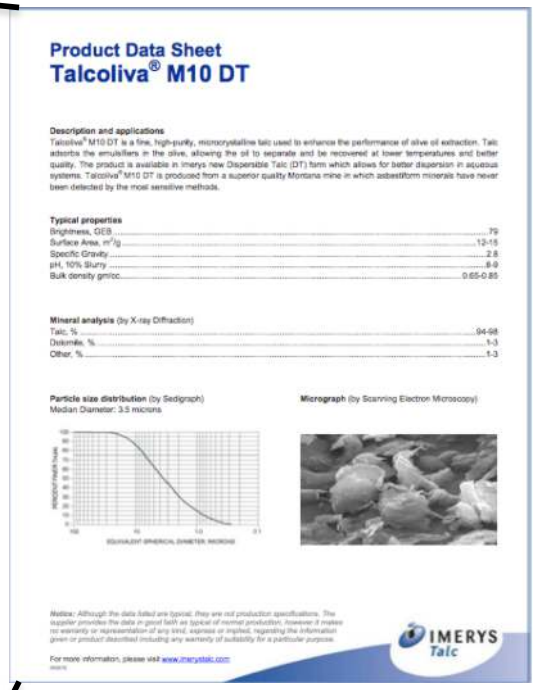


Product Data Sheet
Talcoliva® M10 DT

Description and applications
Talcoliva® M10 DT is a fine, high-purity, microcrystalline talc used to enhance the performance of olive oil extraction. Talc adsorbs the emulsifiers in the olive, allowing the oil to separate and be recovered at lower temperatures and better quality. The product is available in Imerys new Dispersible Talc (DT) form which allows for better dispersion in aqueous systems. Talcoliva® M10 DT is produced from a superior quality Montana mine in which asbestiform minerals have never been detected by the most sensitive methods.

Typical properties

Brightness, GEB	79
Surface Area, m^2/g	12-15
Specific Gravity	2.8
pH, 10% Slurry	8-9
Bulk density gm/cc	0.65-0.85

Mineral analysis (by X-ray Diffraction)

Talc, %	94-98
Dolomite, %	1-3
Other, %	1-3

Particle size distribution (by Sedigraph)
Median Diameter: 3.5 microns

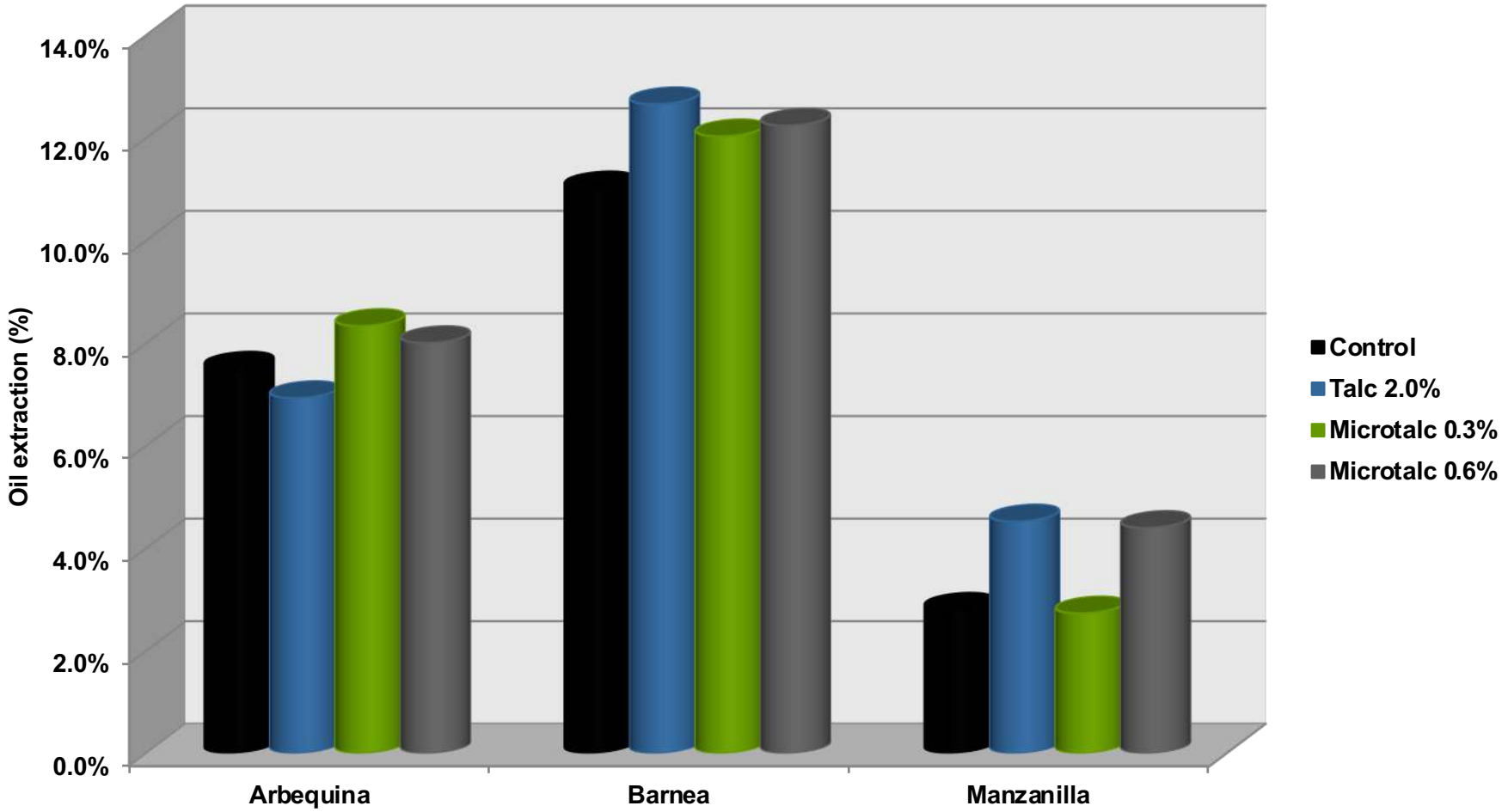
Micrograph (by Scanning Electron Microscopy)

Notice: Although the data listed are typical, they are not production specifications. The supplier provides the data in good faith as typical of normal production, however it makes no warranty or representation of any kind, express or implied, regarding the information given or product described including any warranty of suitability for a particular purpose.

For more information, please visit www.imerystalc.com

IMERYS Talc

Talc & microtalc powder



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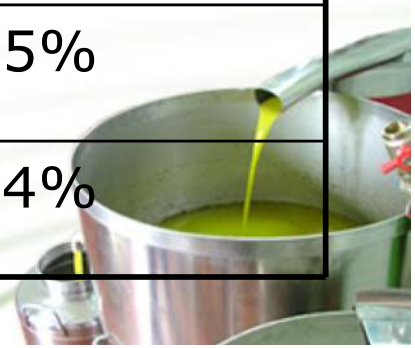
Oil production and quality

Talc powder (> 10µm)

Talc trial in Manzanillo fruit with 61.1% moisture and 3.1 M.I.

Talc rate	Processing speed	Extraction efficiency
0.0%	2.95 tn/hr	74.36%
0.5%	3.45 tn/hr	81.25%
1.0%	3.90 tn/hr	86.34%
1.5%	4.15 tn/hr	88.35%
2.0%	4.15 tn/hr	89.15%
2.5%	4.15 tn/hr	88.74%



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Oil production and quality

Microtalc powder (< 5µm)

Oil loss in pomace

Table 5. Effect of talc addition on oil and water content of pomace

	MNT (%)			
	0	0.25	0.5	1
PM (%)	63 ± 0.3[†]ab[*]	63.3ab ± 0.6ab	63.7a ± 0.9a	61.8ab ± 0.5b
PODW (%)	13.6 ± 0.7a	11.3 ± 0.7b	11.6 ± 1.2ab	12 ± 0.2ab

[*]Different letters within a row mean significant differences ($p < 0.05$) with respect to process step.
[†]Mean ± SD ($n = 3$).

Dosages 0.25% and 0.50% were the most effective

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Oil production and quality

Talc & microtalc powder

When should I consider the use of talc and how much of it?

- With high moisture levels (>56.0%). Do not use if moisture is < 55.0%.
- With difficult varieties (Arbequina, Leccino, Picual, Hojiblanca, Manzanillo).
- With small grids (4 or 5 mm).
- With low extraction efficiencies (< 85.0%).
- Others (Low pumping capacity <60.0% of decanter capacity).
- Start with **1.0%** (if particle size is larger >10µm) or **0.3%** (if particle size is < 10µm) and adjust according to oil content in pomace and pumping capacity.

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Talc & microtalc dosing

- ✓ How: Talc powder dispenser. Adjustment of kg/hour and talc density (tapped density).
- ✓ If manually, addition must be done very slowly while malaxer is being filled.
- ✓ Where: In the malaxer, where the paste is still fresh. Do NOT add where the past is oily.
- ✓ Wear dust masks!

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Oil production and quality

Common salt (NaCl)

- ✓ High solubility in water. It does not make the oil "salty"
- ✓ Action: It changes the density of the water stretching out the gap of water:oil densities
- ✓ Greener oils as it increases chlorophyll solubility
- ✓ Dose = 1-3%
- ✓ Significantly cheaper than talc & microtalc powder

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Oil production and quality

Calcium carbonate

- ✓ Natural mineral with crystalline structure (calcite)
- ✓ It facilitates flocks agglomeration by adsorption (similar action to Talc powder)
- ✓ d50% = 2.8µm
- ✓ Density = 2.7 gr/ml
- ✓ Dose = 1-2%
- ✓ Cheaper than Talc powder
- ✓ Used in Spain with excellent extraction efficiency results

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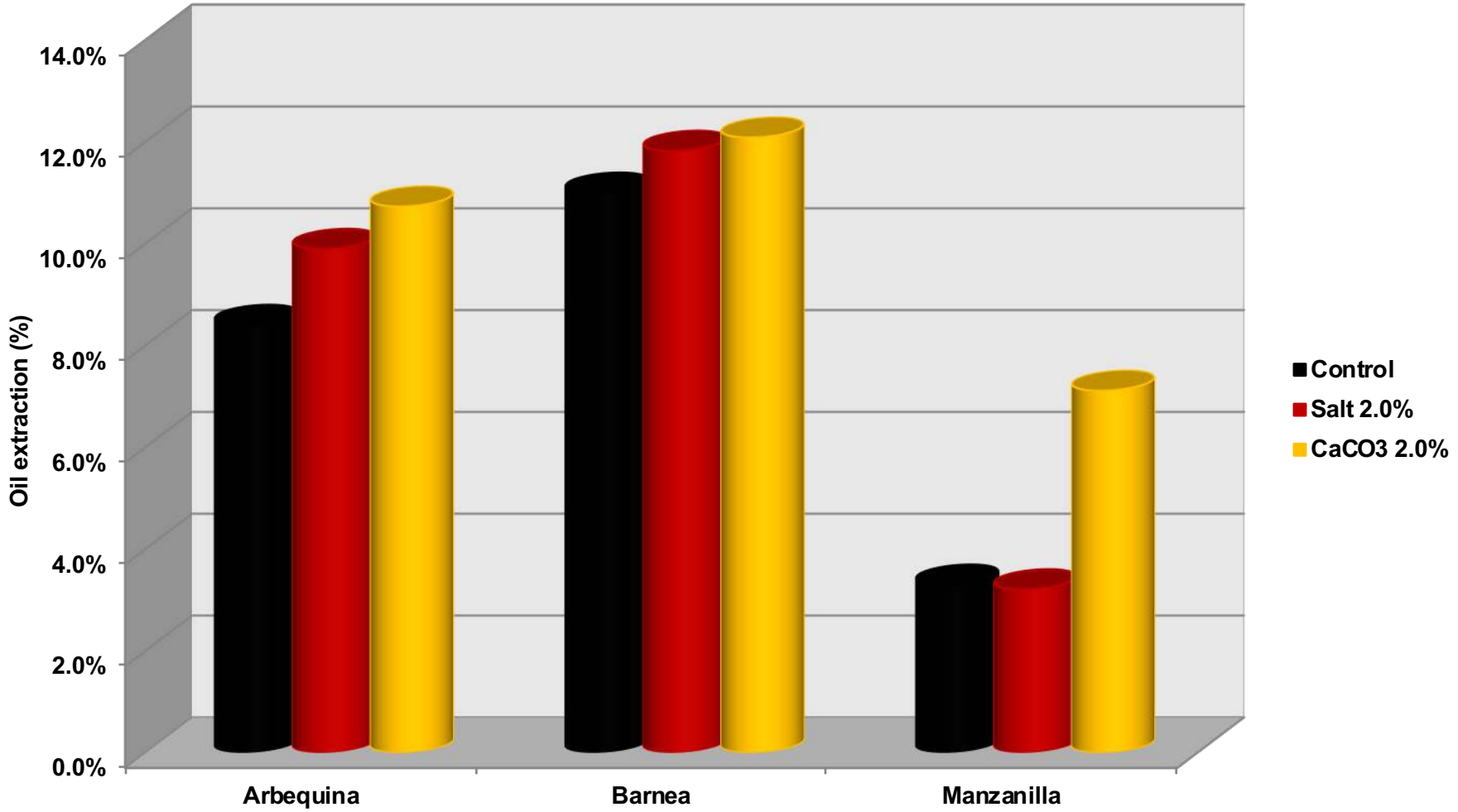
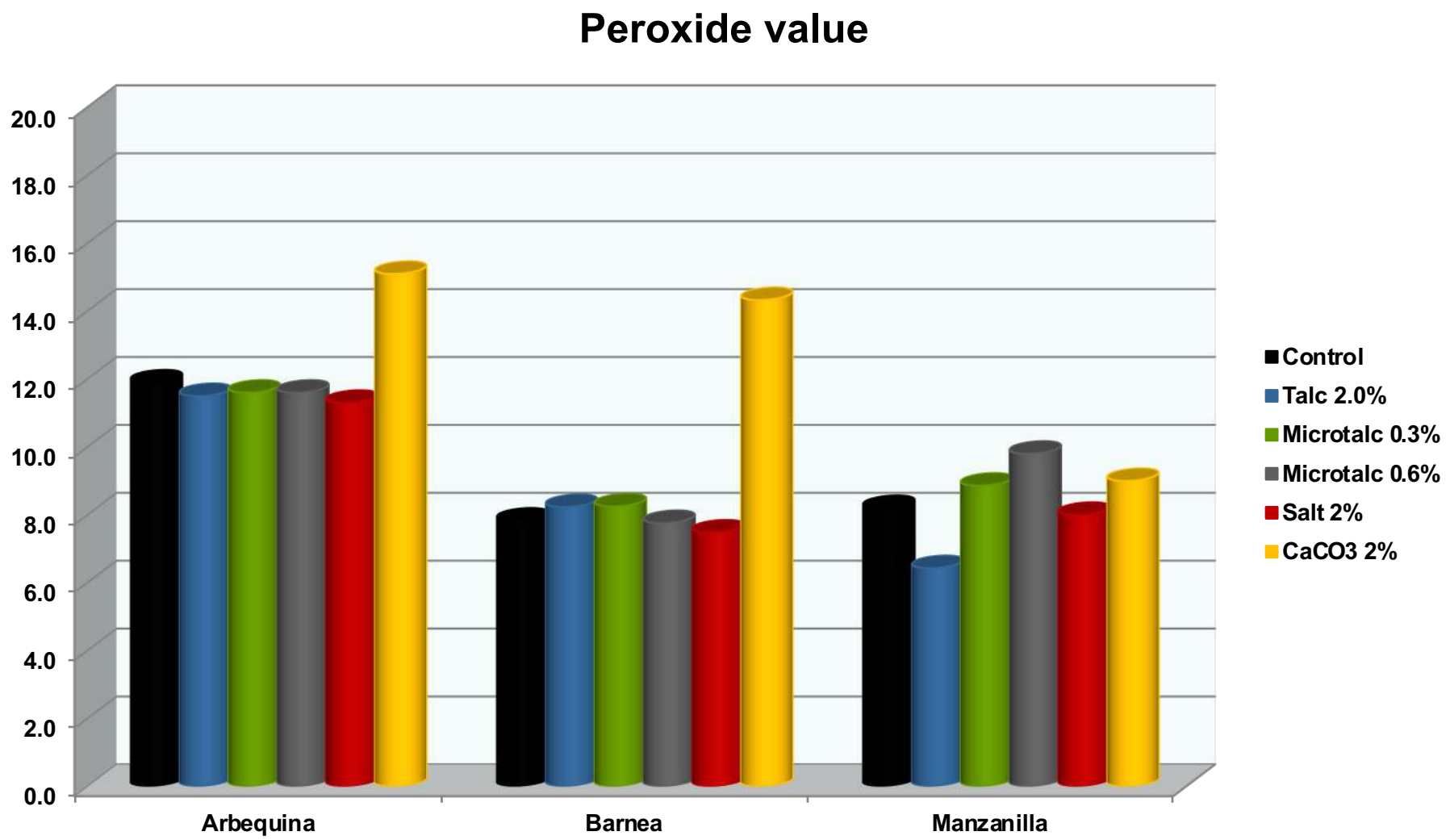
Oil production and quality

Salt & Calcium carbonate



Solid aids


Peroxide value
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Arbequina
Barnea
Manzanilla
Control
Talc 2.0%
Microtalc 0.3%
Microtalc 0.6%
Salt 2%
CaCO3 2%

Salt & Calcium carbonate

Salt (NaCl)

- Improves extractability
- No impact on taste
- Slightly greener oils
- Higher PPH content in oil and slightly higher stability
- Increases CE of pomace

Calcium carbonate

- Aggressive on paste
- Very high extractability
- Reduces FFA
- Increases pH of pomace
- Oxidative action (PV, UV)
- ↓↓ PPH, stability & bitterness
- Very green oils
- Changes in taste

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Oil production and quality

Citric Acid

- Commonly used product for acidification and preservation in the Food industry.
- Studies have shown that it increases Total polyphenols content and oxidative stability (Rancimat®) in EVOO.
- It also increases the chemical bitterness (K225) and sensorial bitterness. Some authors have also reported an increase in FFA.
- Some research studies claim significant increments in industrial efficiency by the use of Citric acid.
- **Application**: During malaxation, in doses from 0.5 to 2.0% (5 to 20lt/ton), prepared as a 30% water solution.
- **Mode of action**: It generates a strong drop of the paste's pH, which leads to a degradation of the pectin chain. This also increases the partitioning of polyphenols in the oil phase. It is also thought that low pH values inhibit the activity of POD.

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Oil production and quality

Citric Acid

Polyphenols and Oxidation stability

Table 4: Effect of citric acid addition on oxidative stability and total polyphenols (TP) content of Koroneiki olive oil extracted by pressure.

Citric acid %	Phenols (mg gallic acid/kg oil)	Oxidative stability	Calculated at ambient temperature		
		Induction period at 100°C (hrs.)	Induction period (months)	Shelf- life (months)	Expired period (months)
0% (Control)	201.11±1.05^{d}	36.20±1.85^{c}	20.05±1.47^{c}	36.89±1.47^{d}	53.75±1.58^{d}
0.5%	210.22±2.14^{c}	37.84±2.15^{c}	20.96±1.58^{c}	38.56±2.14^{c}	56.17±1.28^{c}
1%	253.33±1.25^{b}	45.6±1.64^{b}	25.26±2.58^{b}	46.47±1.84^{b}	67.69±2.84^{b}
1.5%	312.22±1.41^{a}	56.2±2.47^{a}	31.13±2.12^{a}	57.38±1.24^{a}	83.58±1.37^{a}
2.0%	314.44±1.20^{a}	56.6±2.85^{a}	31.35±1.85^{a}	57.68±1.15^{a}	84.018±1.38^{a}

Means within a column followed by the same letter are not significantly different ($p \leq 0.05$).

Table 5: Effect of citric acid addition on oxidative stability and total polyphenols (TP) content of Coratina olive oil extracted by pressure.

Citric acid %	Phenols (mg gallic acid/kg oil)	Oxidative stability	Calculated at ambient temperature		
		Induction period at 100°C (hrs.)	Induction period (months)	Shelf- life (months)	Expired period (months)
Control	216.66±1.52^{e}	39.00±1.57^{d}	21.61±2.54^{d}	39.76±2.15^{d}	57.90±1.68^{d}
0.5%	242.22±1.15^{d}	43.6±2.47^{c}	24.15±1.58^{c}	44.44±1.82^{c}	64.72±1.84^{c}
1%	303.33±1.83^{c}	54.6±1.39^{b}	30.25±1.59^{b}	55.66±1.45^{b}	81.07±2.15^{b}
1.5%	307.83±1.57^{b}	55.41±2.85^{b}	30.70±2.14^{b}	56.49±2.45^{b}	82.28±1.58^{b}
2.0%	343.33±1.22^{a}	61.8±2.38^{a}	34.24±1.57^{a}	63.00±1.23^{a}	91.75±1.14^{a}

Means within a column followed by the same letter are not significantly different ($p \leq 0.05$).

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Oil production and quality

Source: Al-Okaby et al

Enzymes

- ✓ Very effective in improving the paste extractability
- ✓ Biologically active protein substances that help in degrading the pectin & cellulose of the cell walls & vacuoles
- ✓ They are produced from Aspergillus aculeatus or niger
- ✓ **Same enzymes that the fruit has in its tissues**
- ✓ Endogenous enzyme system depends on the season, variety & maturity and is inactivated by polyphenols
- ✓ Dose = Variable (200-500ml/tn). Higher in dry years
- ✓ Water soluble and easily removed by centrifugation
- ✓ Absolutely essential when dealing with low maturity fruit

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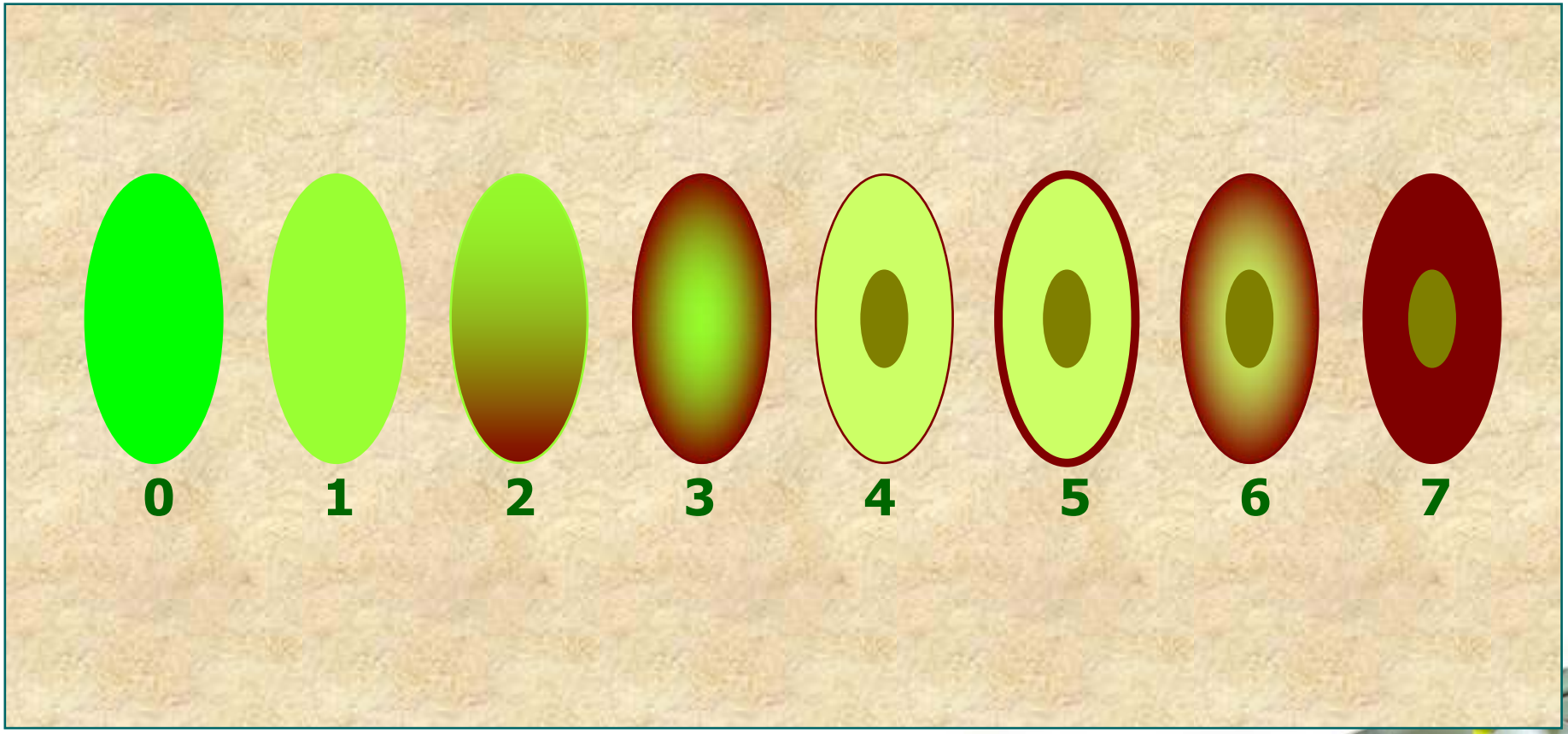
Oil production and quality

Enzymes



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Oil production and quality

Maturity and pectin degradation

Changes in Texture, Total Pectins (TP), and Pectin Esterification Degree in Fruits During Ripening of Olives[a]

Ripeness stage	Harvest date	Texture (N/100 g of fruits)	TP (mg GA/100 g dry wt of fruits)	Degree of esterification (%)
Ripe-green	11/30/98	3889.6 ± 155.3	1678.6 ± 72.2	63.30
	12/7/98	3023.5 ± 140.7	1464.3 ± 60.0	65.34
Small reddish spots	12/14/98	2537.2 ± 108.8	882.4 ± 41.5	44.12
Turning color	12/21/98	2428.4 ± 112.4	852.9 ± 38.4	42.42
	12/28/98	2394.7 ± 98.2	823.5 ± 41.1	40.88
Purple	1/4/99	2253.6 ± 112.9	789.5 ± 31.3	27.39
	1/11/99	2260.5 ± 90.4	763.2 ± 32.2	27.59
Black-1	1/18/99	2119.7 ± 97.5	680.5 ± 30.6	23.39
Black-2	1/25/99	1358.3 ± 57.8	580.0 ± 25.0	24.21
Ripe-black	1/2/99	1027.6 ± 52.5	510.6 ± 21.4	12.03

[a]Black-1, fruits with black surface and white pulp; Black-2, fruits with black surface and purple pulp; GA, galacturonic acid.

Source: Minguez-Mosquera et al

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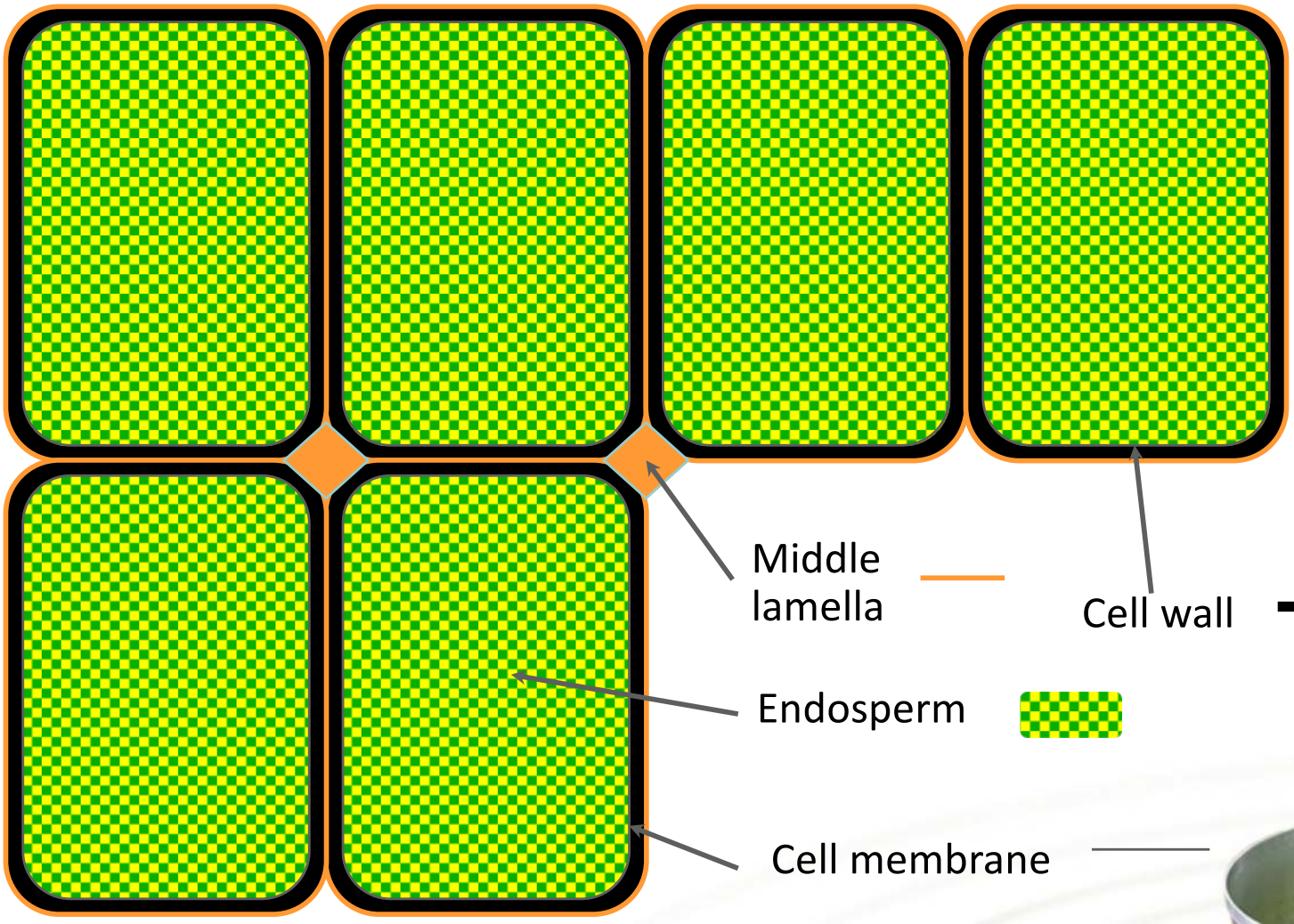
Enzymes



Source: Gunter Maier (NOVOZYMES)

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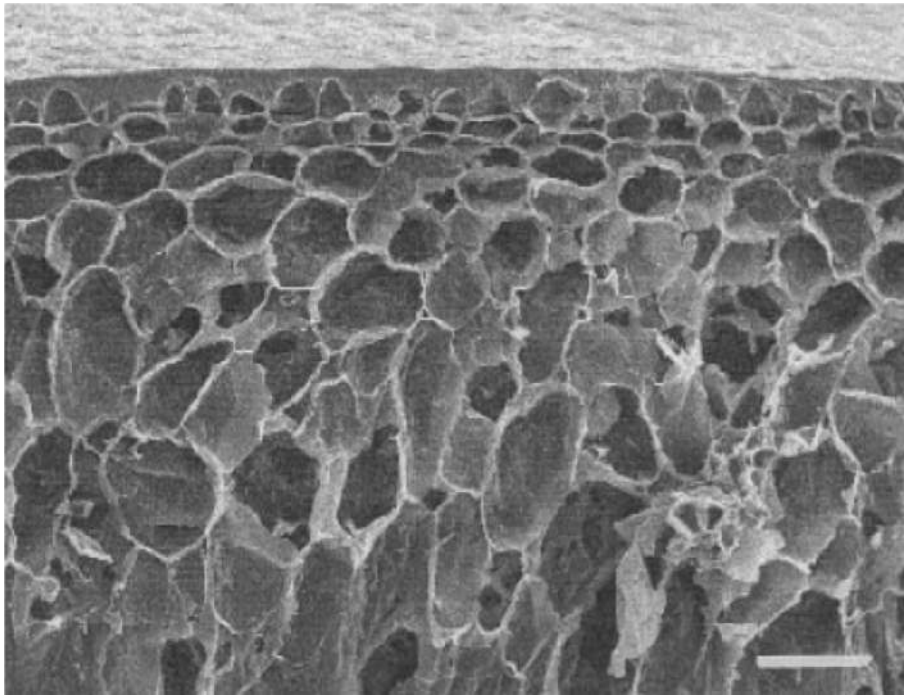
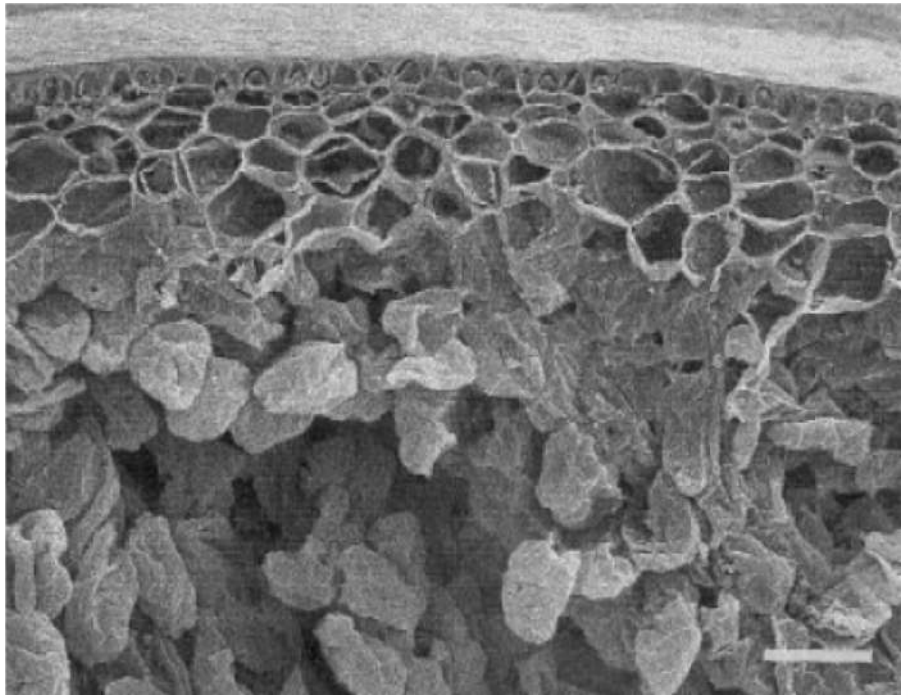
Enzymes

MIDDLE LAMELLA DEGRADATION





Source: Mafra et al. 2001

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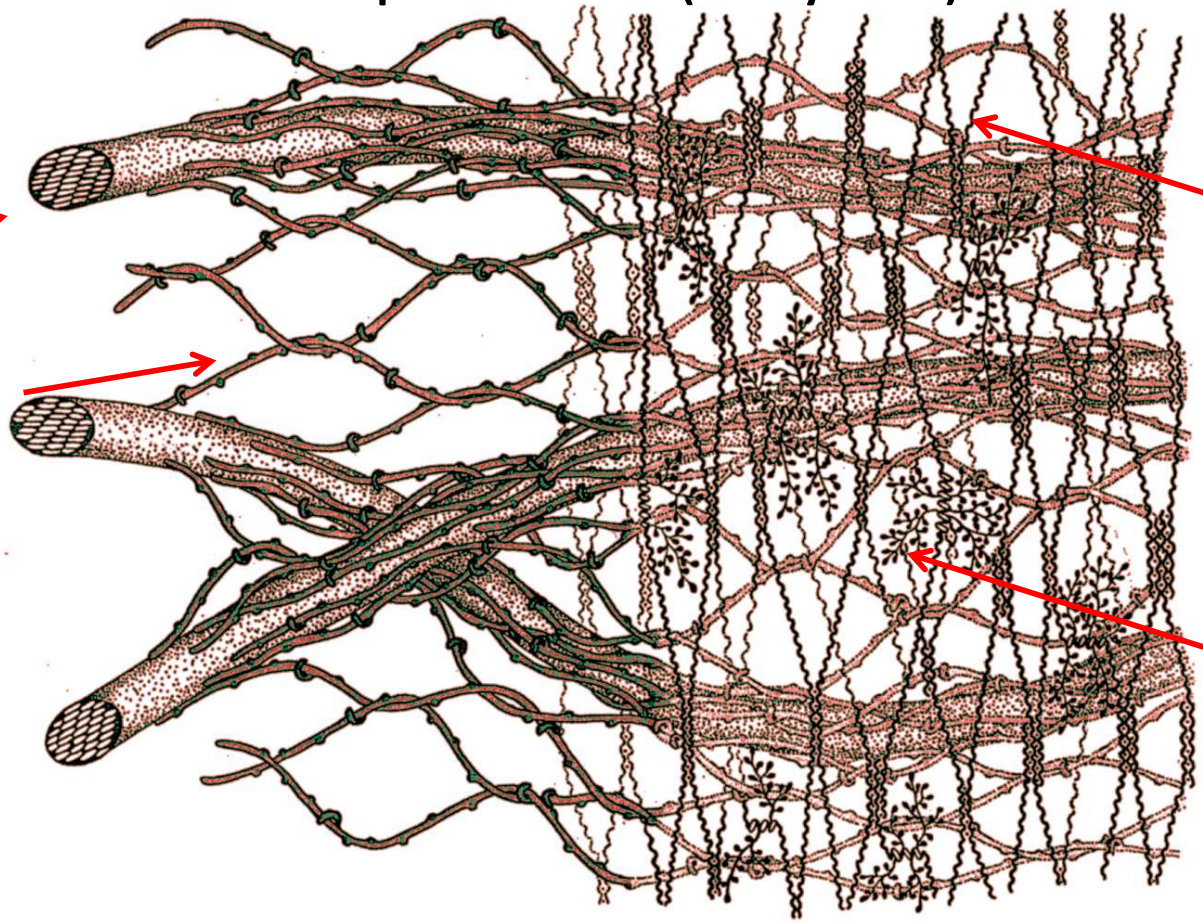
Enzymes

Model of plant cell wall (dicotyledon)



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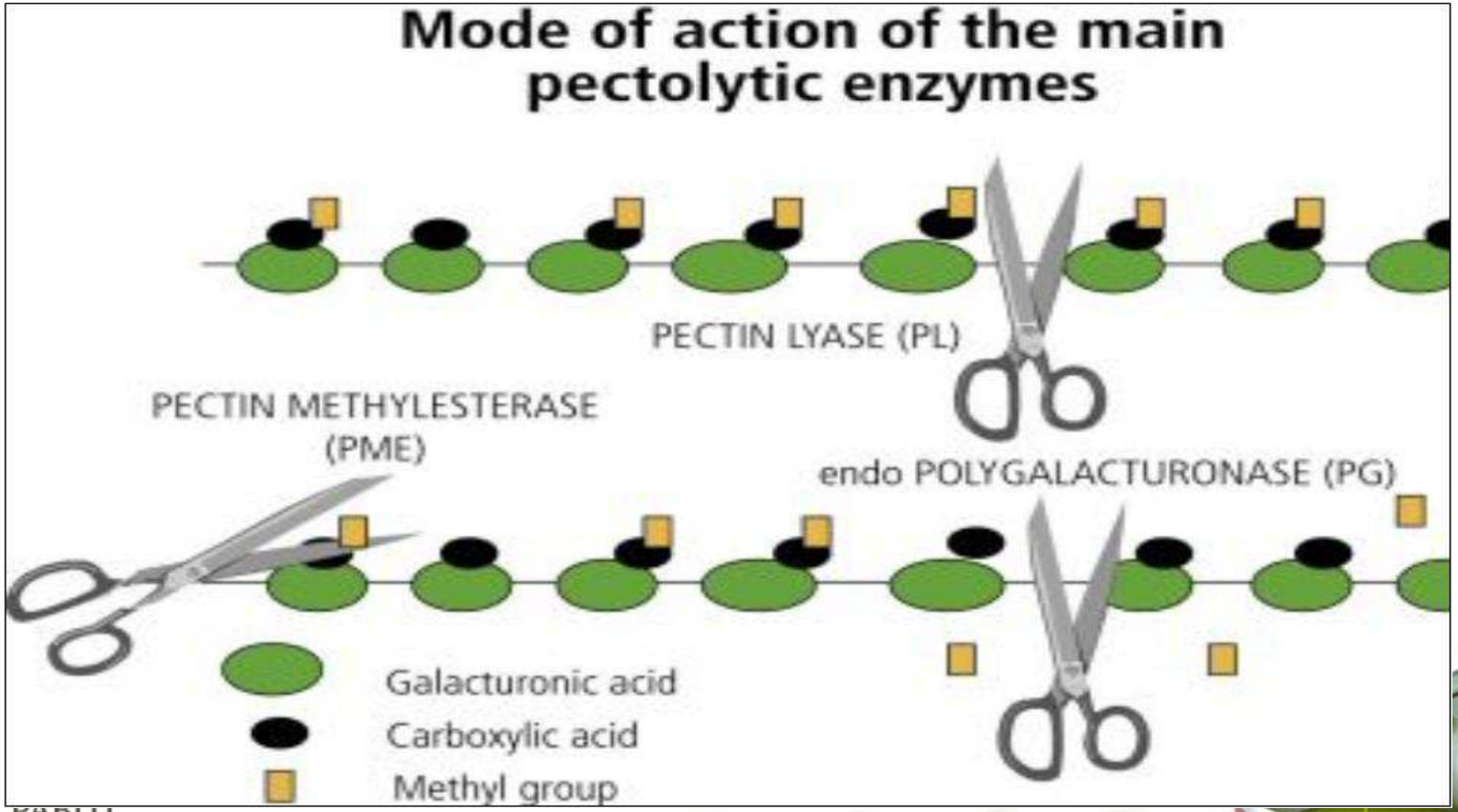
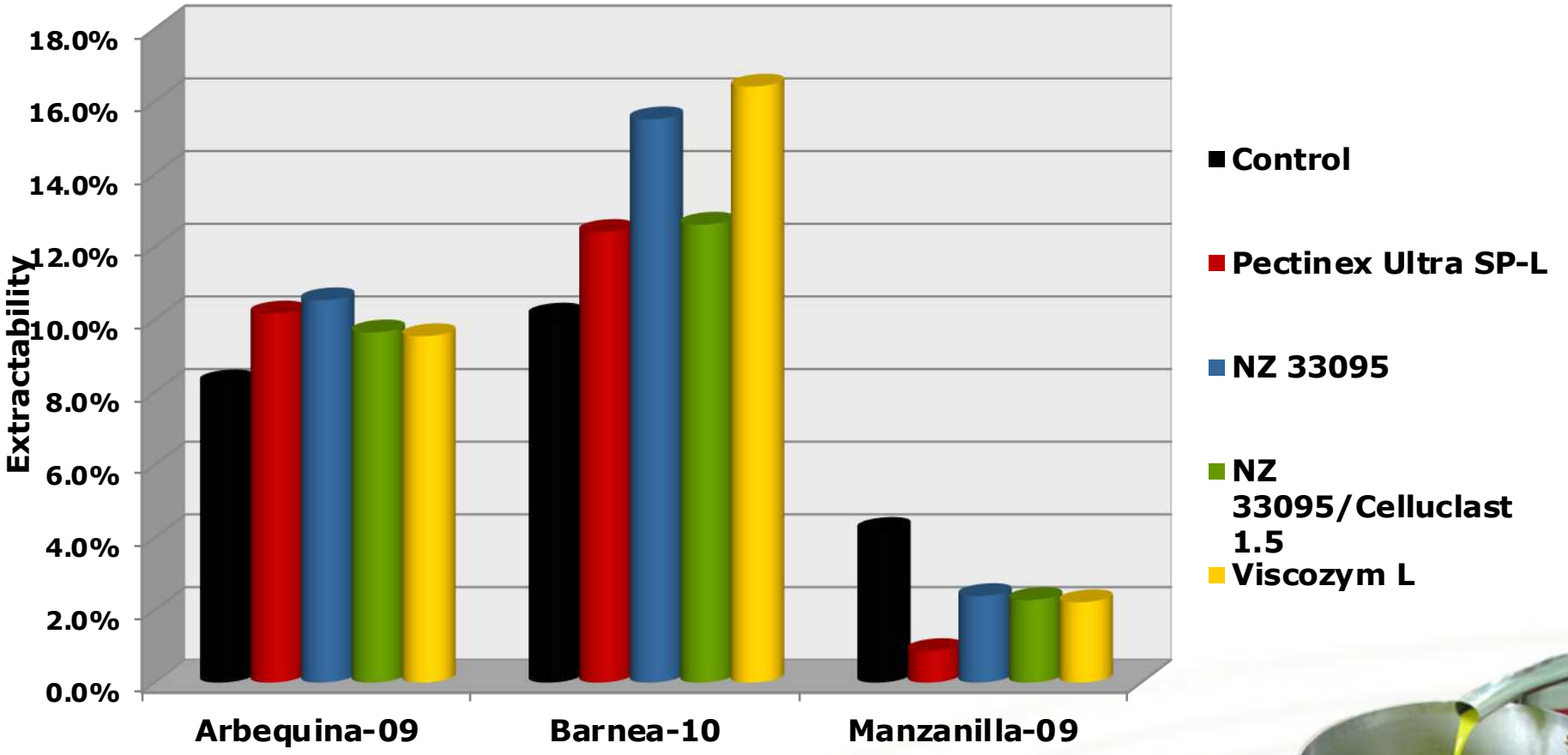
Enzymes


Mode of action of the main pectolytic enzymes
PECTIN LYASE (PL)
PECTIN METHYLESTERASE (PME)
endo POLYGALACTURONASE (PG)
Galacturonic acid
Carboxylic acid
Methyl group

Enzymes

Impact of the use of enzimes on paste extractability



Source: Boundary Bend Olives

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Enzymes

When should I use enzymes and how much of it?

- ✓ **With green fruit (MI <3.5)**
- ✓ With difficult varieties (Arbequina, Leccino, Picual, Hojiblanca, etc).
- ✓ With large grids (6 or 7 mm).
- ✓ With low extraction efficiencies (< 85.0%).
- ✓ Others (Low pumping capacity <60.0% of decanter capacity).
- ✓ Start with **400ml/tn** (if MI<2.5) or **300ml/tn** (if MI>2.5) and adjust according to oil content in pomace (or yields) and pumping capacity.

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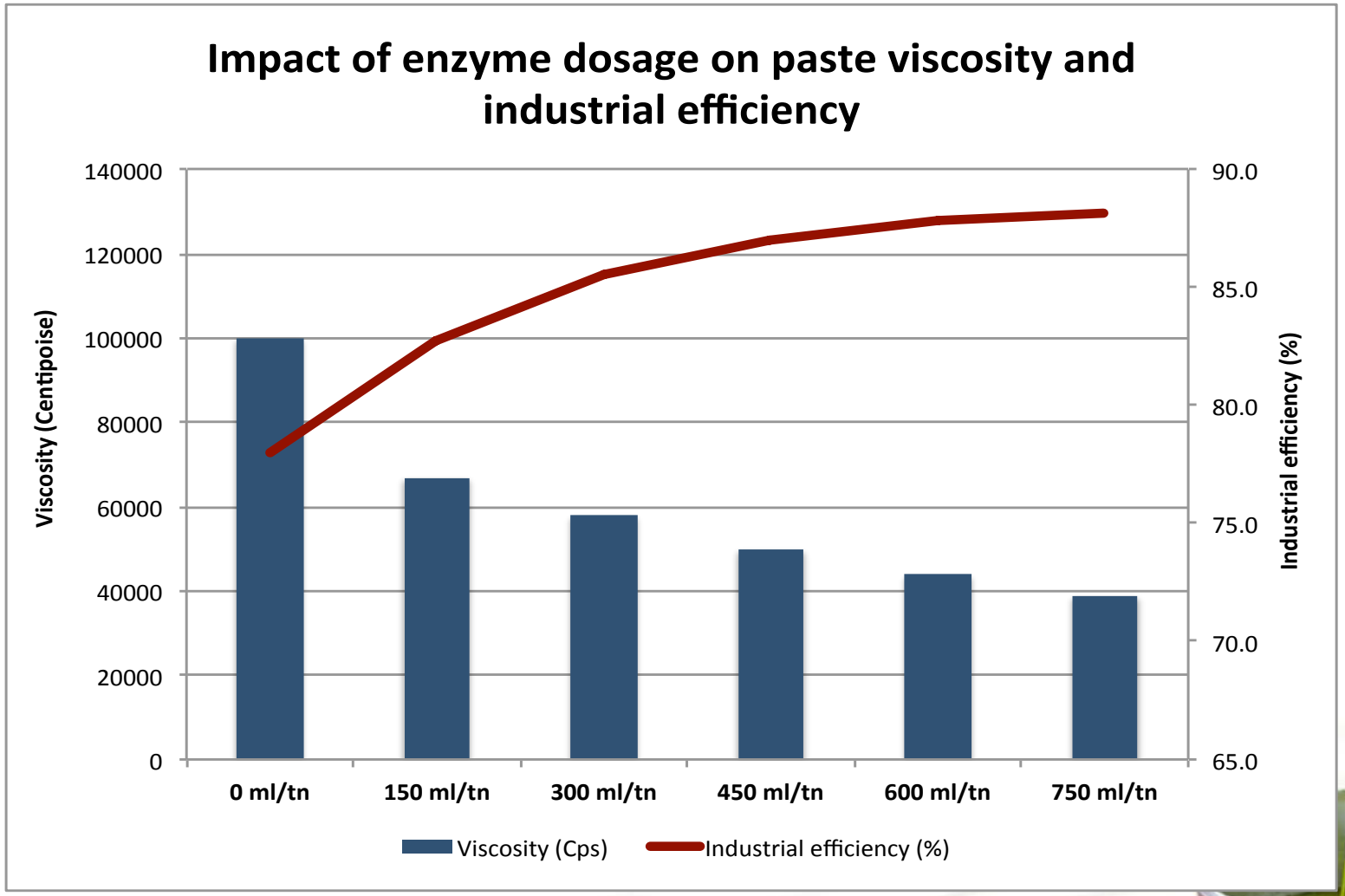
Dosage impact



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Enzymes & talc combination

- ✓ Talc powder and enzymes can be used together safely.
- ✓ The use of each of these products will depend on the fruit condition.
- ✓ They can be added at the same time in the malaxer, provided that enzymes are not dripped on top of the talc.
- ✓ In case of pastes that are excessively fluid, the addition of talc will make more effective the enzymes action on oil release.
- ✓ It is expected that the use of these two products together will help in producing cleaner oils from the decanter (lower particles in suspension)

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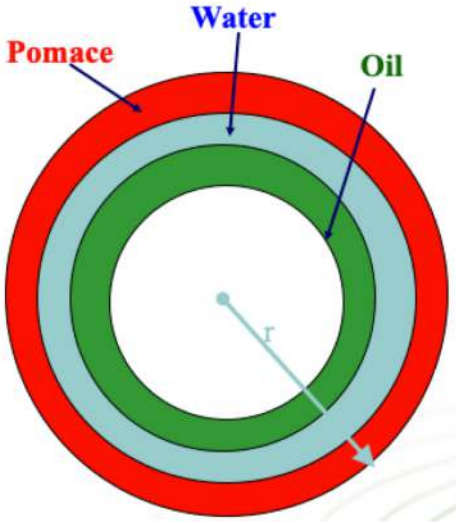
Adjustments for enzymes usage

- ✓ The use of enzymes increase the amount of oil being freed, and the size of the oil ring inside the decanter.
- ✓ Open up oil plates to capture the extra oil.
- ✓ Try adding some 3-4% water to help evacuating the oil from the decanter.
- ✓ If using 3-phase & 2½-phase decanter, ensure both oil and water plates are opened up.
- ✓ Enzymes dry out pomace. Pomace becomes much drier
- ✓ Enzymes increase paste fluidity. Slow down paste pump a bit.



Enzymes dosing

- ✓ How: Use dosing pumps with the ability to pump 8-10lt/h
- ✓ If manually, it is better to add all the enzymes required in a malaxer at once, right at the beginning of malaxation so as to increase contact time
- ✓ Where: Immediately after crusher (if using pump), or in malaxer (if manually)
- ✓ Water dilution 4:1 to 5:1

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Water of injection or addition

Water injection = Pump speed x (Moisture 2 – Moisture 1)/100 + Pump speed x (Moisture 2 – Moisture 1) x 1,25/100

Moisture 1 = Actual fruit moisture

Moisture 2 = targeted fruit mositure

Paste speed = Paste pump speed (kilos/hour)

Example: The fruit moisture measured is 51.0% and it is intended to reach a value of 55.0%. The paste pump speed is 6,000 kg/h.

Water injection = 6,000 x (55 – 51)/100 + 6,000 x (55 – 51) x 1,25/100

Water injection = **540 lt/hora**

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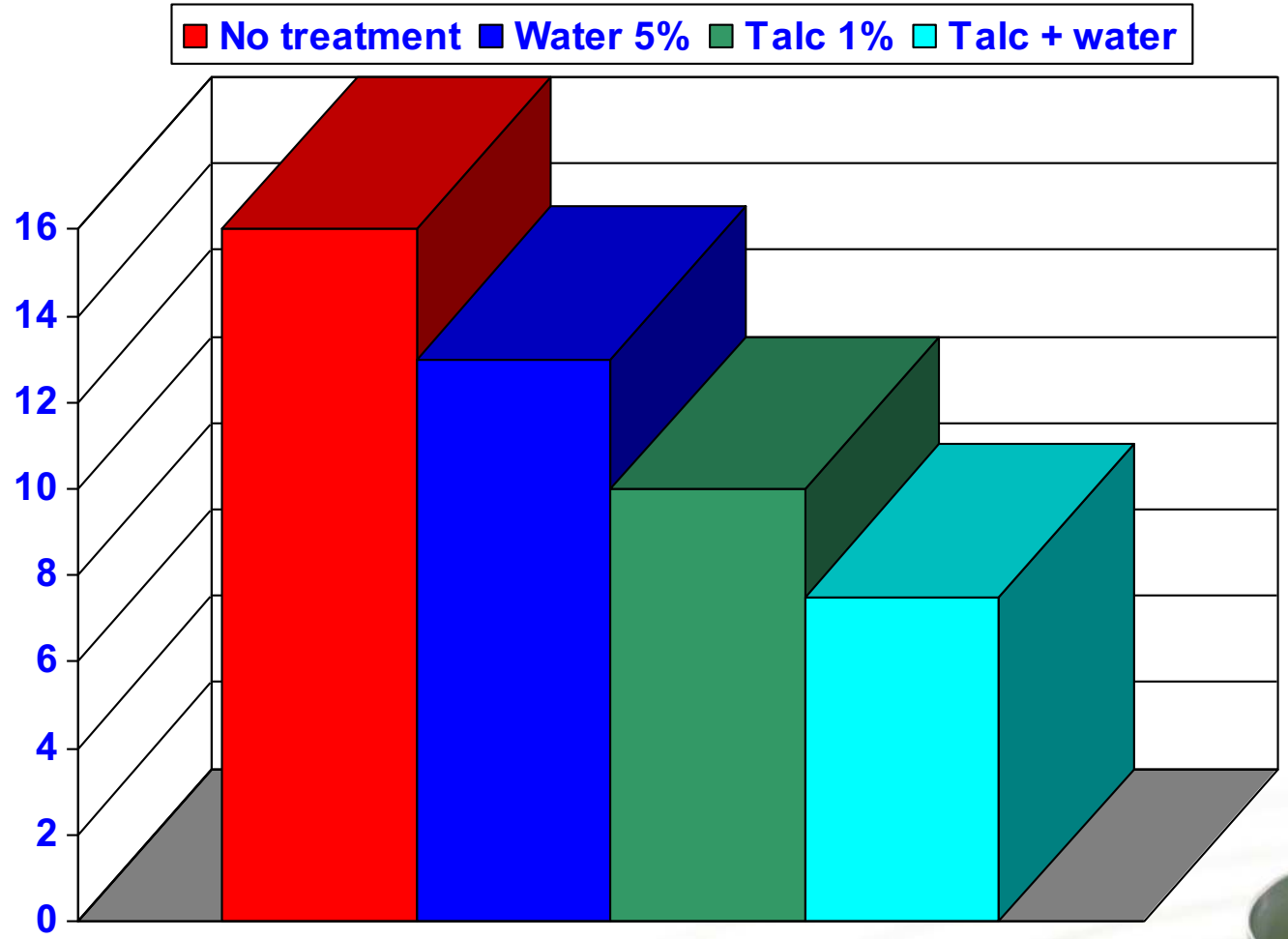
Water of injection



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Marino Uceda – Australia 2005

Fruit: 45% moisture

Water of injection