

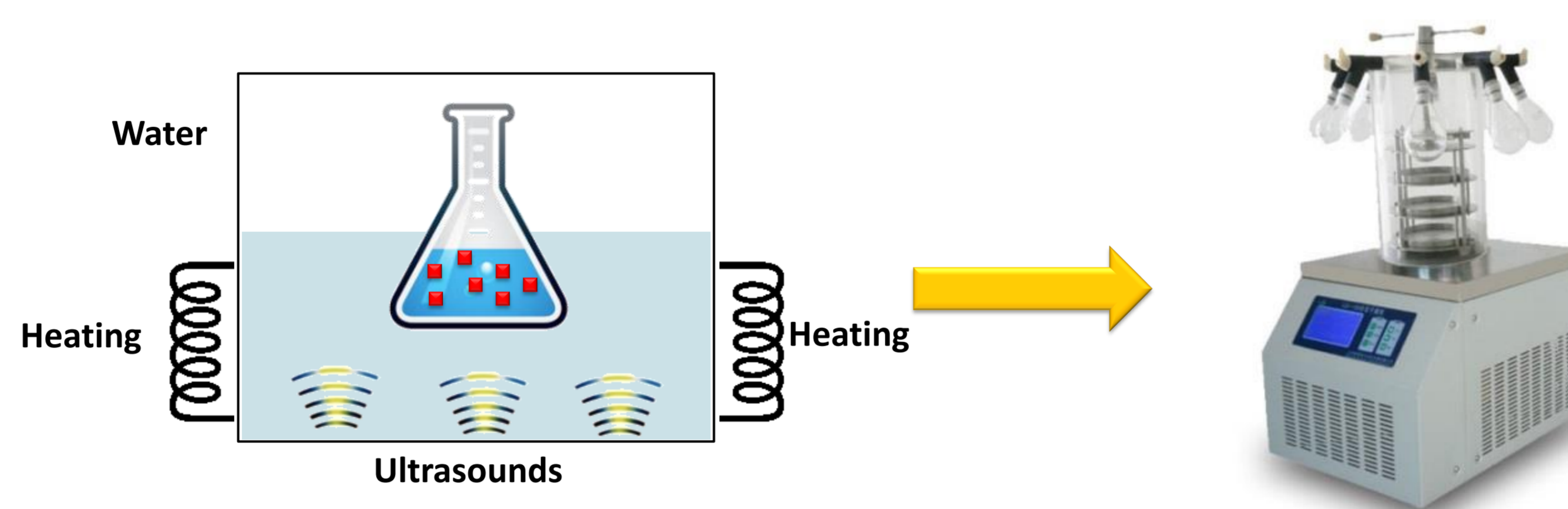
Effect of ultrasounds and firming agents on osmotic + freeze-dried strawberries

Valentina Prosapio*, Ian Norton

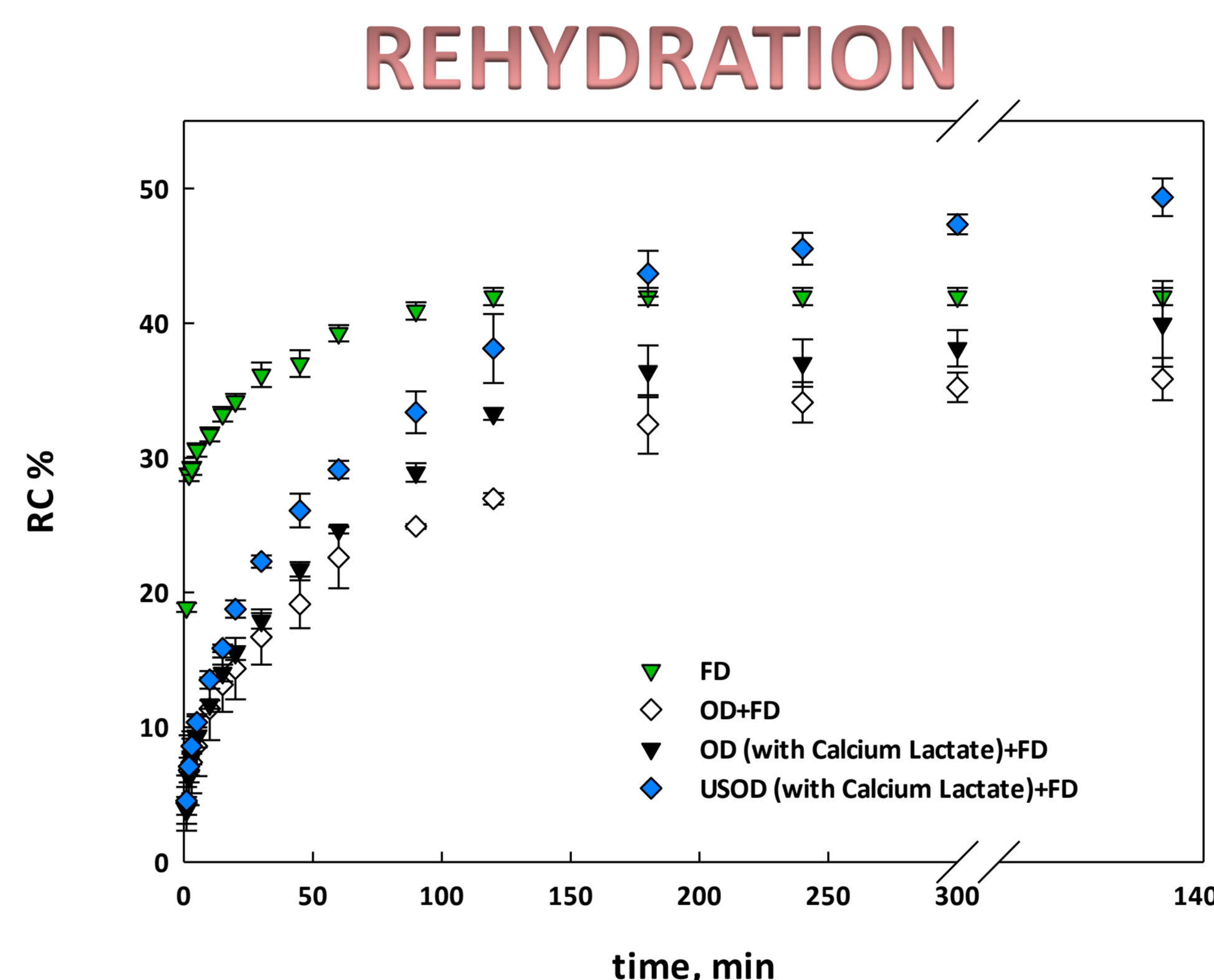
School of Chemical Engineering, University of Birmingham, Edgbaston, Birmingham B15 2TT, United Kingdom

Osmotic dehydration (OD) is used prior to a conventional drying technique to produce an intermediate dried product, thus reducing the overall drying process time. However, it has been observed that, when applied prior to freeze-drying (FD), it causes a decrease of the extent of rehydration compared to FD alone and lower firmness compared to the fresh food.

In this work, the simultaneous application of firming agents and ultrasounds (US) during OD has been studied, using strawberry as a model food. Firming agents and US have been used separately but never combined. US are generally employed to enhance the mass transfer, but they may induce the formation of micro-channels that can cause the collapse of the food microstructure. For this reason, in the current work, Calcium lactate was added in the osmotic solution to strengthen the cell walls, thus reducing the damages produced by ultrasounds and heat.

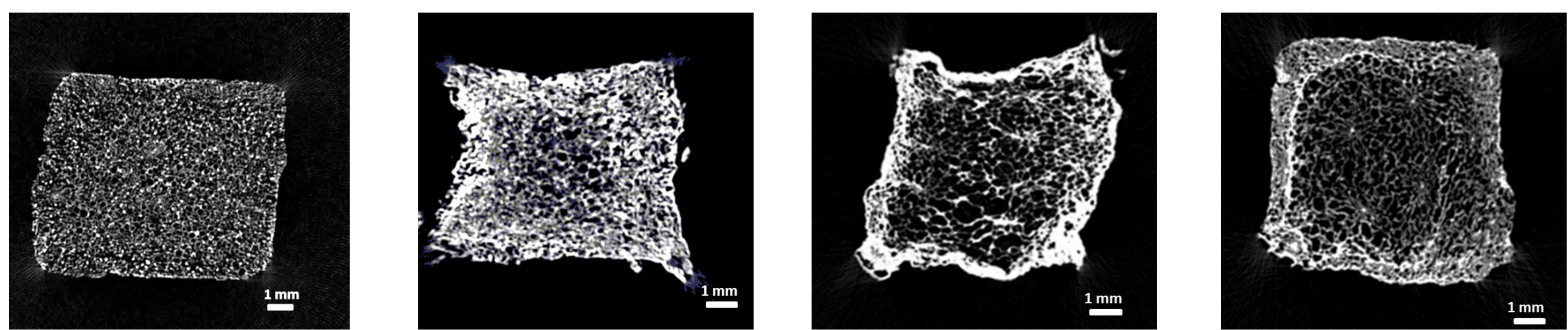


Process	Firming agent	t [h]	a_w	MC [g/100g]	RC %
FD	-	18	0.195±0.007	7.38±0.80	42.15±1.32
OD+FD	-	3+7	0.302±0.074	8.98±2.82	36.55±1.02
OD+FD	Calcium lactate	3+7	0.429±0.007	12.00±2.38	40.84±1.23
USOD+FD	-	0.25+7	0.686±0.102	27.87±1.93	n.p.
	Calcium lactate	0.5+7	0.421±0.014	20.14±2.49	49.74±1.40
	Calcium lactate	2+7	0.395±0.009	18.76±2.14	32.07±4.66
		3+7	0.285±0.074	10.01±7.33	29.45±1.59



The use of US for 30 min during OD leads the highest RC and a processing time reduction of about 83% compared to classic OD (180 min)

MICROSTRUCTURE



FD

OD+FD

OD (CaLact)+FD

USOD (CaLact)+FD

Reduced collapse

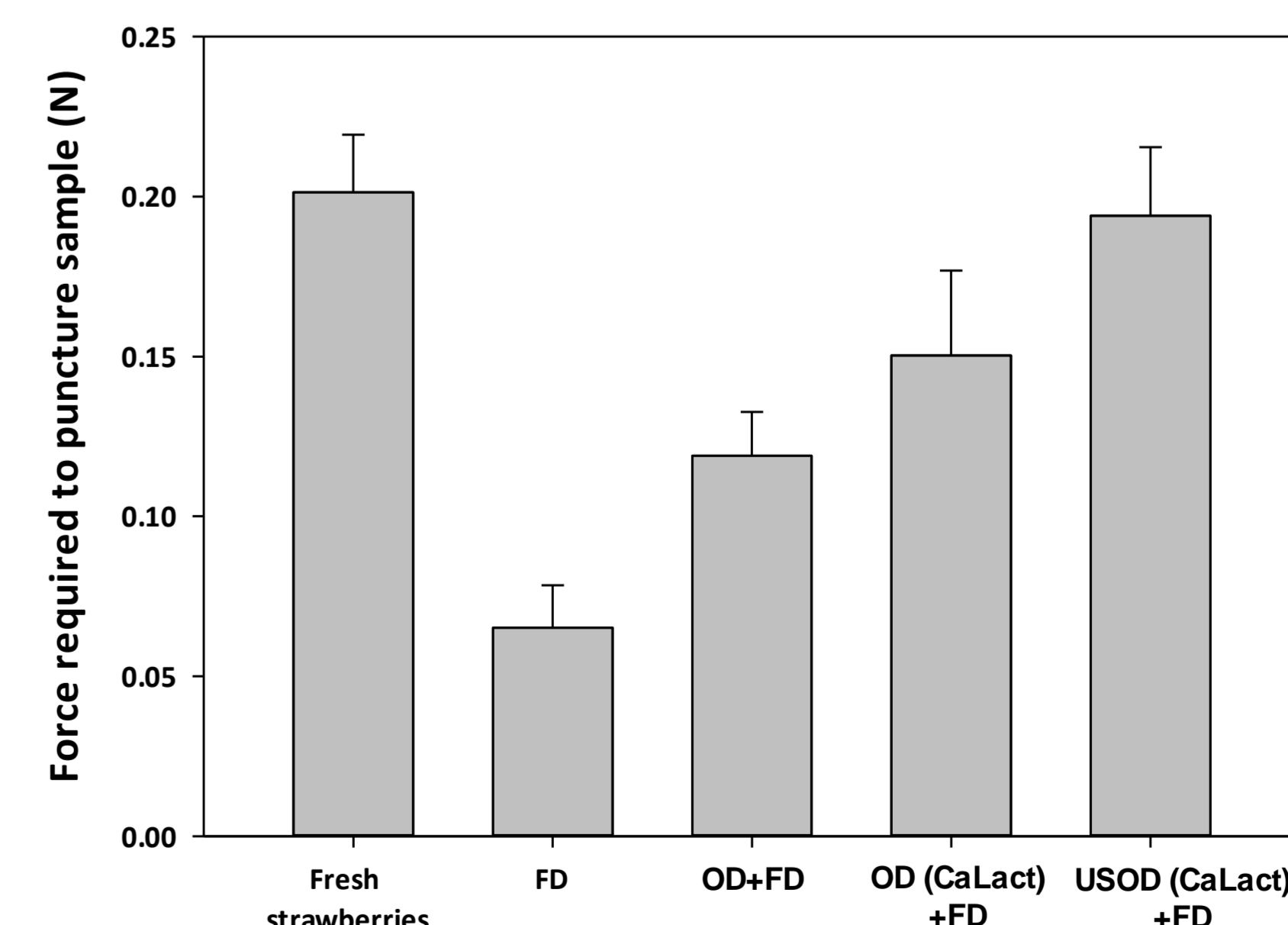
Sample	Porosity %
FD	80.90±3.56
OD+FD	41.07±11.58
OD (CaLact)+FD	57.52±6.76
USOD (CaLact)+FD	61.25±0.03

COLOUR

Sample	L*	a*	b*	C _{ab} *	ΔE
Fresh strawberry	57.54±1.79	65.34±5.15	53.48±8.58	84.52±9.09	-
FD	74.00±11.35	32.96±11.45	30.06±7.10	45.11±11.20	43.65±15.71
OD+FD	60.00±14.32	48.70±15.91	34.81±12.42	59.91±19.98	28.77±19.17
OD+FD (CaLact)	59.72±15.51	47.43±7.90	36.11±9.79	58.89±8.79	29.94±9.91
USOD+FD (CaLact)	55.57±4.04	58.39±4.21	44.47±3.75	73.53±2.84	12.99±2.00

When OD was performed with US, the colour indicators are the closest to the original colour of fresh strawberry

TEXTURE



The highest firmness preservation is observed for samples treated with Calcium lactate and US for 30 min during OD