'Milking the Dairy Industry' to avoid waste

by

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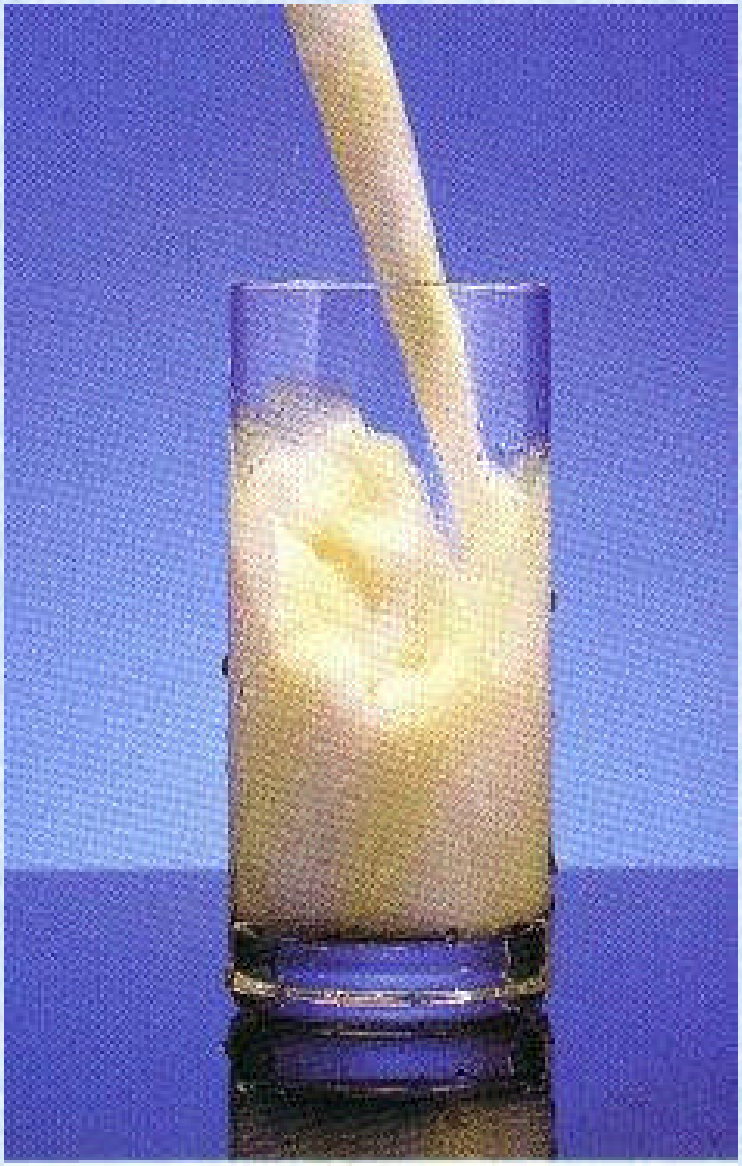
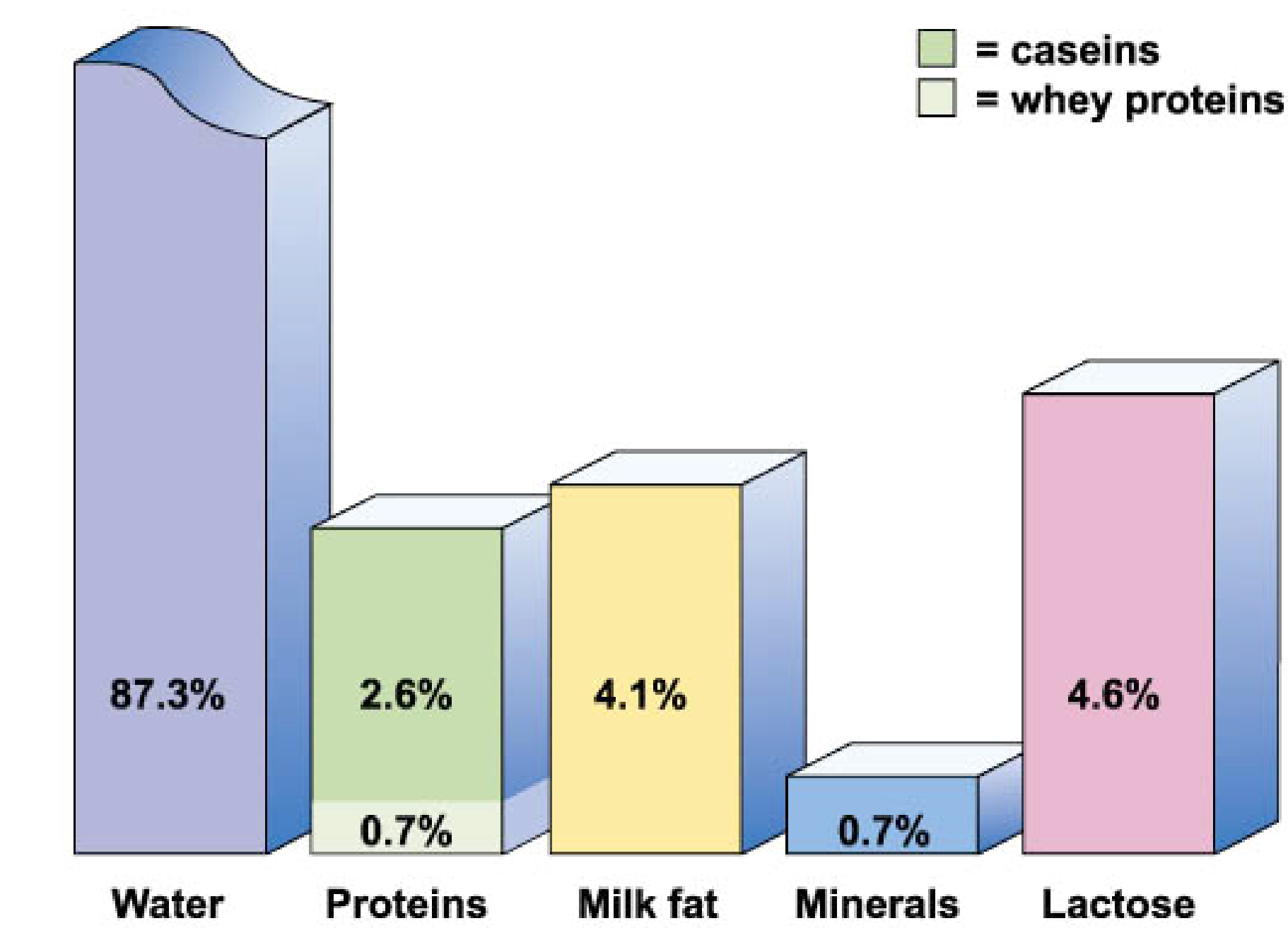
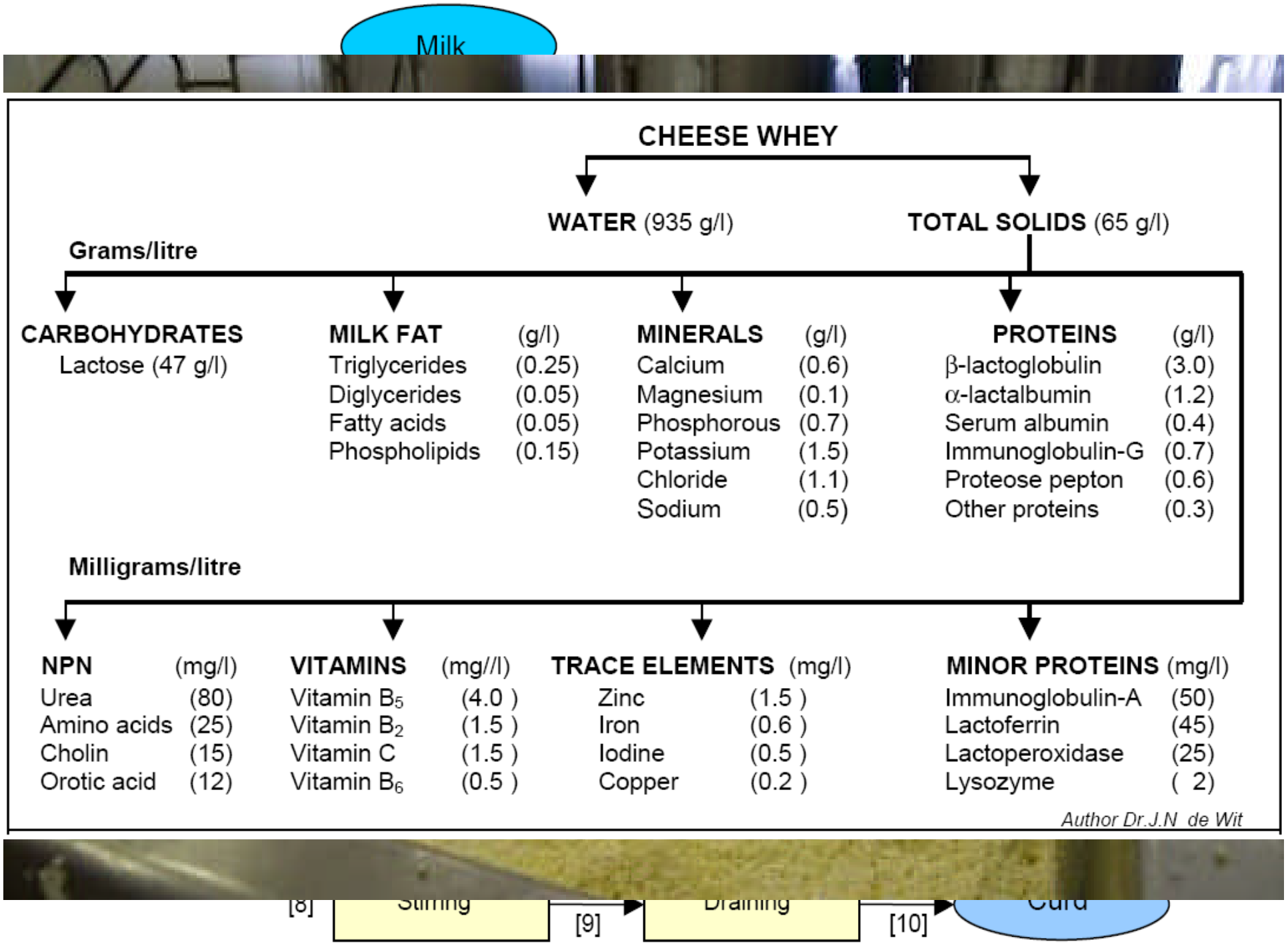


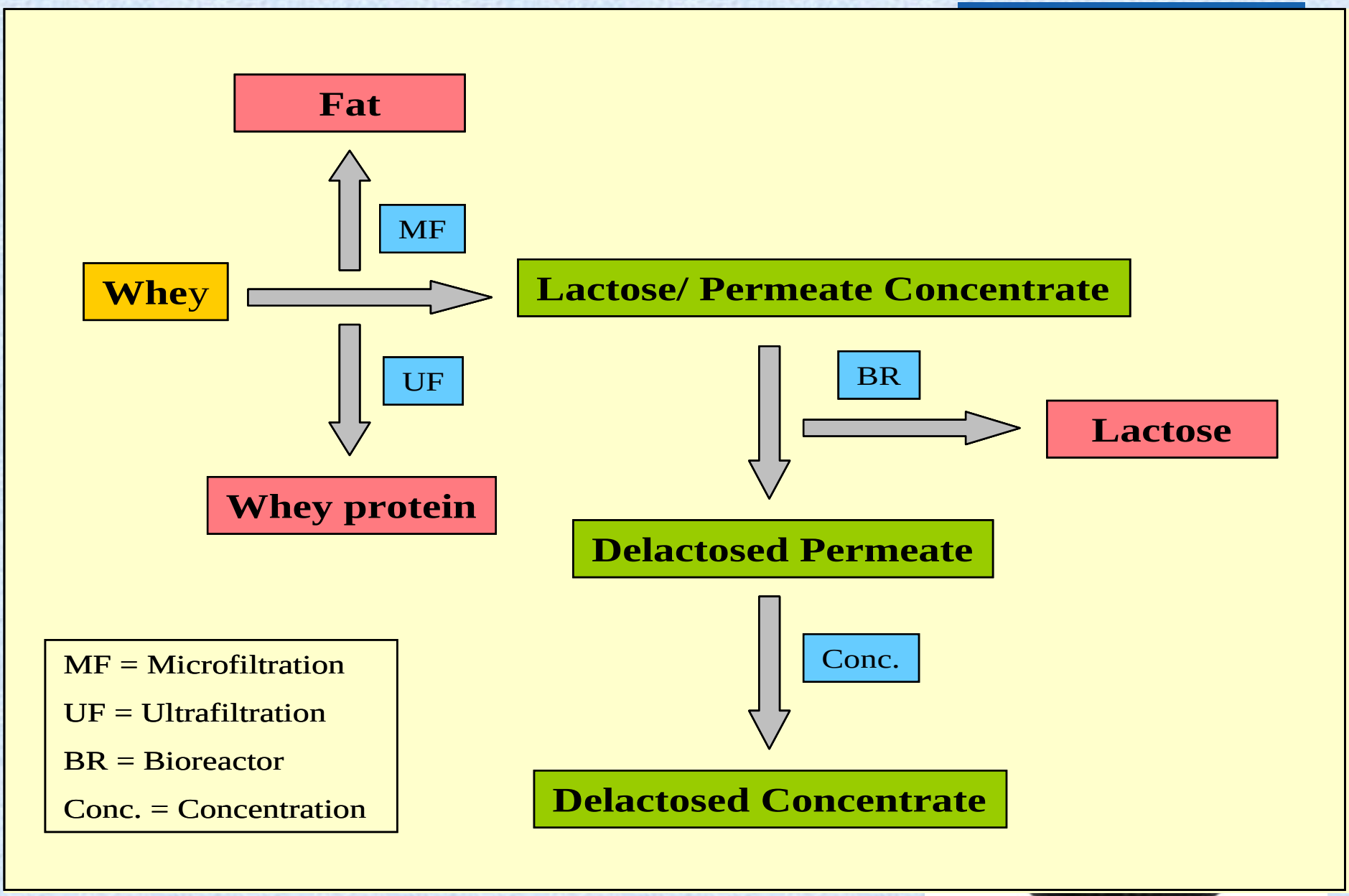
Days

Weeks

Months


= caseins
= whey proteins
87.3%
2.6%
0.7%
4.1%
0.7%
4.6%
Water
Proteins
Milk fat
Minerals
Lactose


Milk
CHEESE WHEY
WATER (935 g/l)
TOTAL SOLIDS (65 g/l)
Grams/litre
CARBOHYDRATES
Lactose (47 g/l)
MILK FAT (g/l)
Triglycerides (0.25)
Diglycerides (0.05)
Fatty acids (0.05)
Phospholipids (0.15)
MINERALS (g/l)
Calcium (0.6)
Magnesium (0.1)
Phosphorous (0.7)
Potassium (1.5)
Chloride (1.1)
Sodium (0.5)
PROTEINS (g/l)
β-lactoglobulin (3.0)
α-lactalbumin (1.2)
Serum albumin (0.4)
Immunoglobulin-G (0.7)
Proteose pepton (0.6)
Other proteins (0.3)
Milligrams/litre
NPN (mg/l)
Urea (80)
Amino acids (25)
Cholin (15)
Orotic acid (12)
VITAMINS (mg//l)
Vitamin B5 (4.0)
Vitamin B2 (1.5)
Vitamin C (1.5)
Vitamin B6 (0.5)
TRACE ELEMENTS (mg/l)
Zinc (1.5)
Iron (0.6)
Iodine (0.5)
Copper (0.2)
MINOR PROTEINS (mg/l)
Immunoglobulin-A (50)
Lactoferrin (45)
Lactoperoxidase (25)
Lysozyme (2)
Author Dr.J.N de Wit
[8]
Stirring
[9]
Draining
[10]
Curd


Fat
MF
Whey
Lactose/ Permeate Concentrate
UF
BR
Lactose
Whey protein
Delactosed Permeate
Conc.
Delactosed Concentrate
MF = Microfiltration
UF = Ultrafiltration
BR = Bioreactor
Conc. = Concentration

DIT

Examine the applicability of **whey permeates** to **preserve & enhance** the nutritional quality of fresh and processed **fruits and vegetables**.

- Irish vine-ripened tomatoes (*Lycopersicon esculentum* L. Mill. cv. Moneymaker)
- Irish Strawberries (*Fragaria × ananassa* Duch. var Elsanta)

Methods

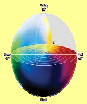
Microbiology

- Mesophillic
- Psycrotrophic
- LAB
- Yeast & Mould

Sensory analysis

Metabolic Indicators

- Respiration rate
- pH
- Colour
- Water content
- Ash
- total soluble solids
- Water Activity



Antioxidant Activity Test

- DPPH
- FRAP

Antioxidant Compounds

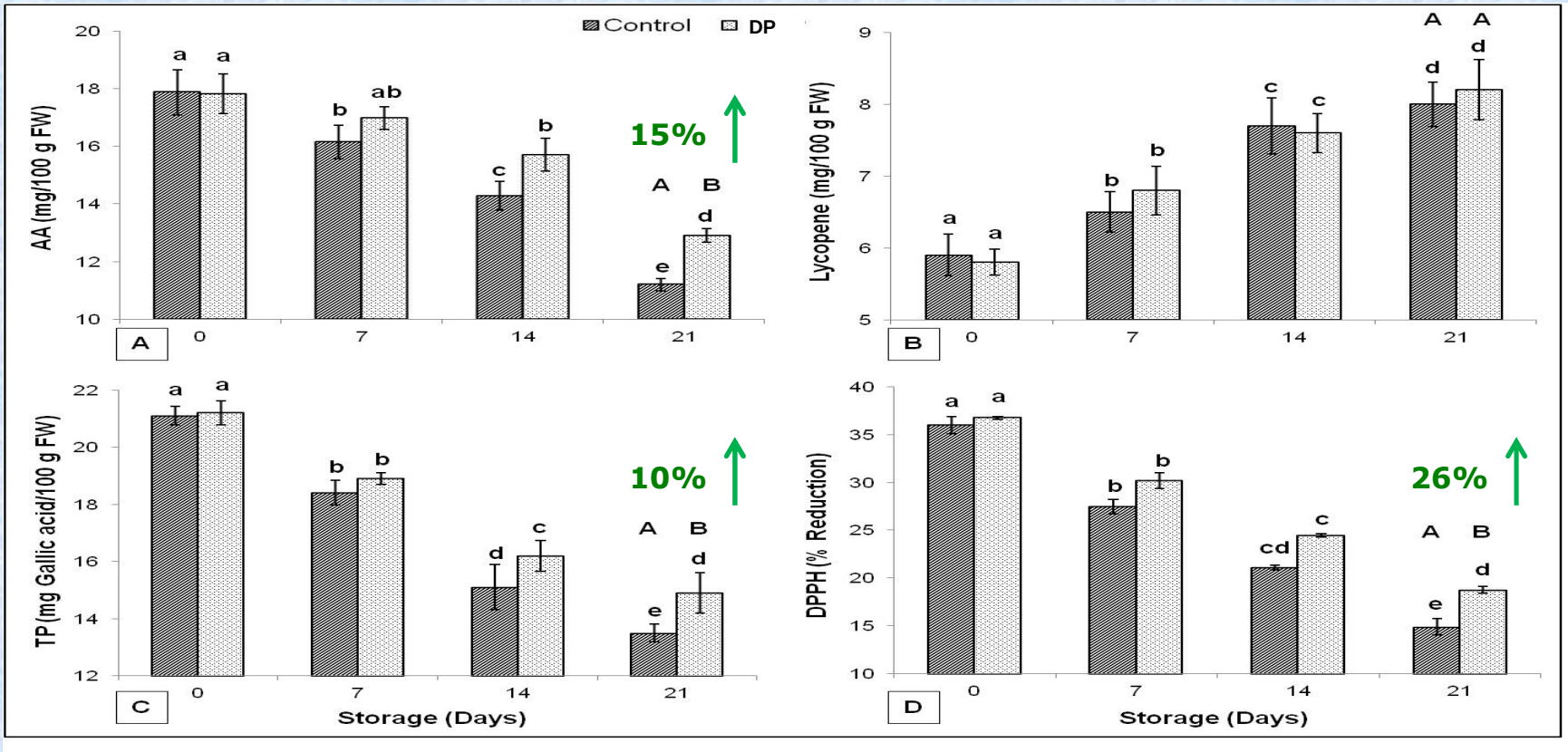
- Lycopene
- Ascorbic Acid
- Total Phenol
- Mineral & Trace Elements

Enzymatic Activity

- Peroxidase
- PME

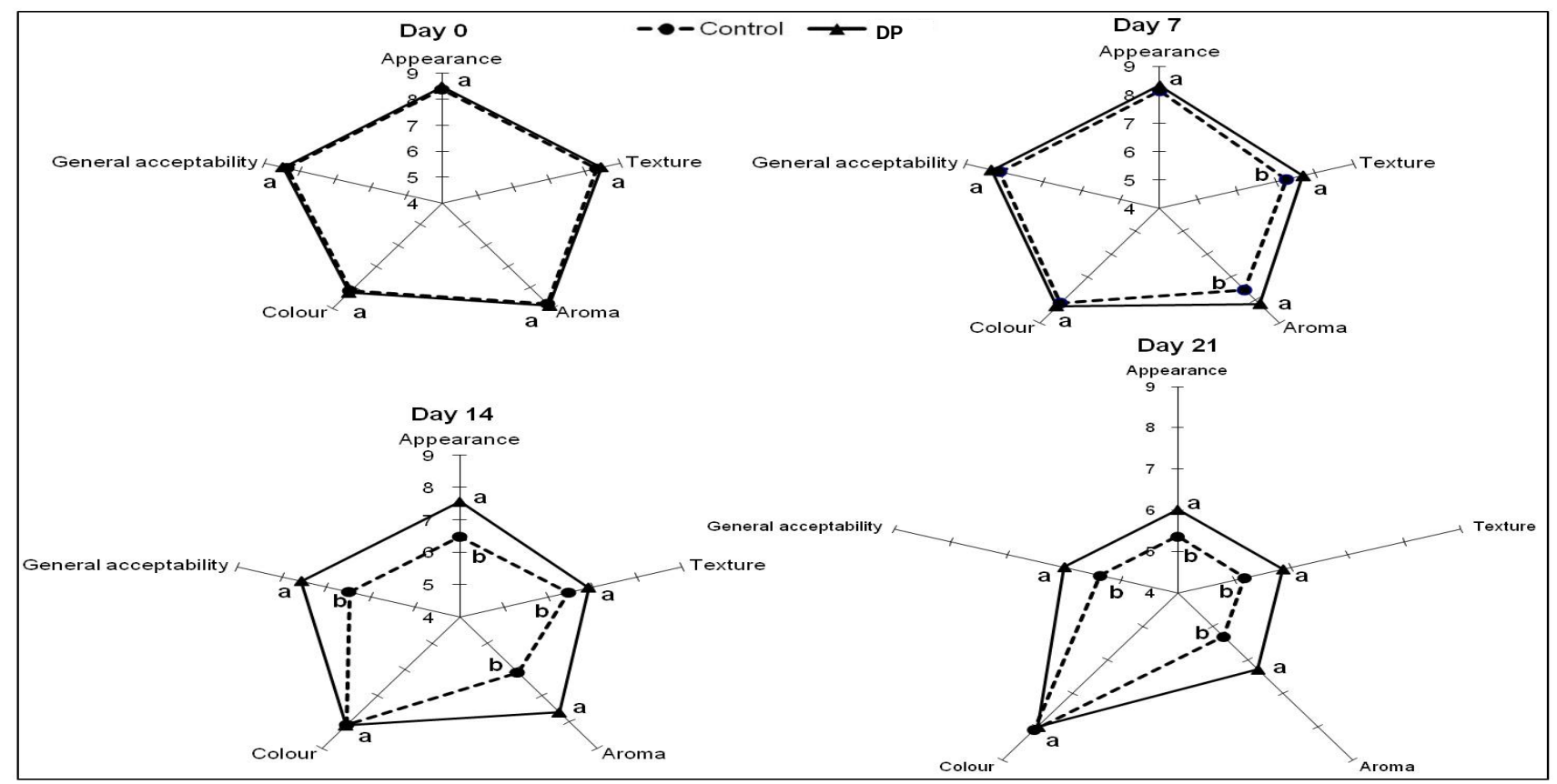
Physico-chemical, Nutritional and Microbial Markers tested

Whole Tomatoes



Effect of whey delactosed permeate (DP) and chlorine treatment on (A) ascorbic acid (AA), (B) lycopene, (C) total phenols and (D) antioxidant activity - DPPH in whole tomatoes during 21 days of storage at 15 °C

Whole Tomatoes

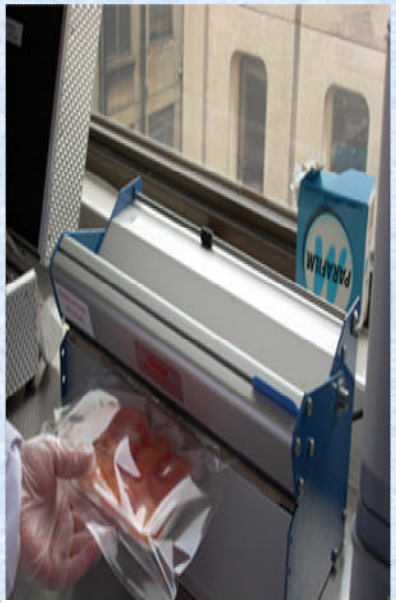


Sensory evaluation of whole tomatoes after whey delactosed permeate (DP) and chlorine treatment and stored at 15 °C for 21 days.

Sliced Tomatoes

Slicing tomatoes

100 g tomato slices

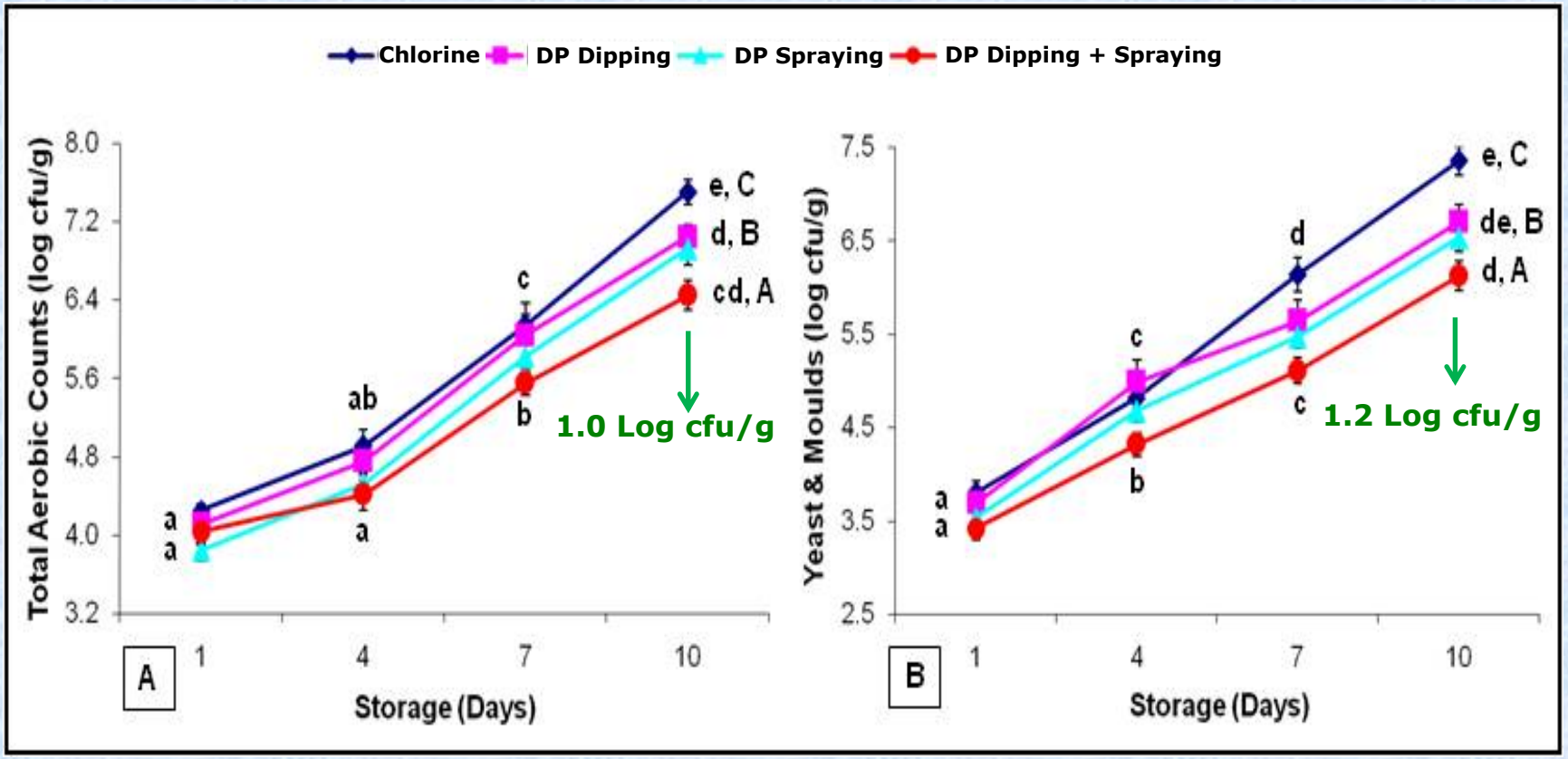


Heat sealing

Tomato packages

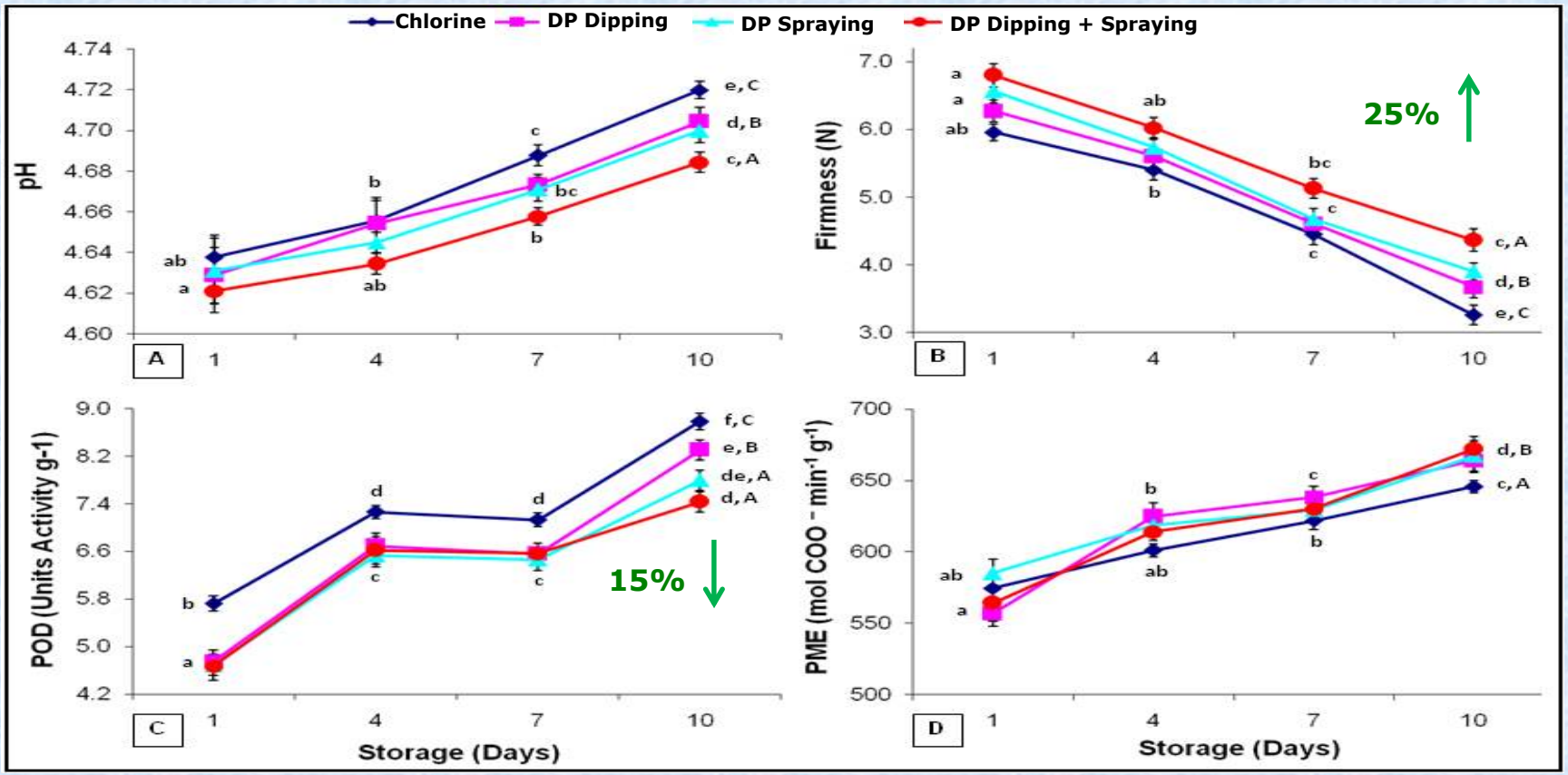
Processing steps for fresh-cut tomatoes

Sliced Tomatoes



Effect of chlorine and whey delactosed permeate (DP) treatments by dipping, spraying and a combination of both methods on total aerobic counts (A) and yeast and moulds (B) during 10 days storage of fresh-cut tomato at 4 °C.

Sliced Tomatoes



Changes in (A) pH, (B) texture, (C) peroxidase (POD) and (D) pectin methyl esterase (PME) of fresh-cut tomatoes treated with chlorine and whey delactosed permeate (DP) by dipping, spraying and a combination of both methods during the 10 days of storage at 4 °C

Canned Tomatoes

Irish Plum Tomatoes

Removing the skin

Tomatoes with DP + NaCl + Citric acid

Barriquand Steriflow canning machine

Storage at RT

Processing steps for canned tomatoes

Canned Tomatoes

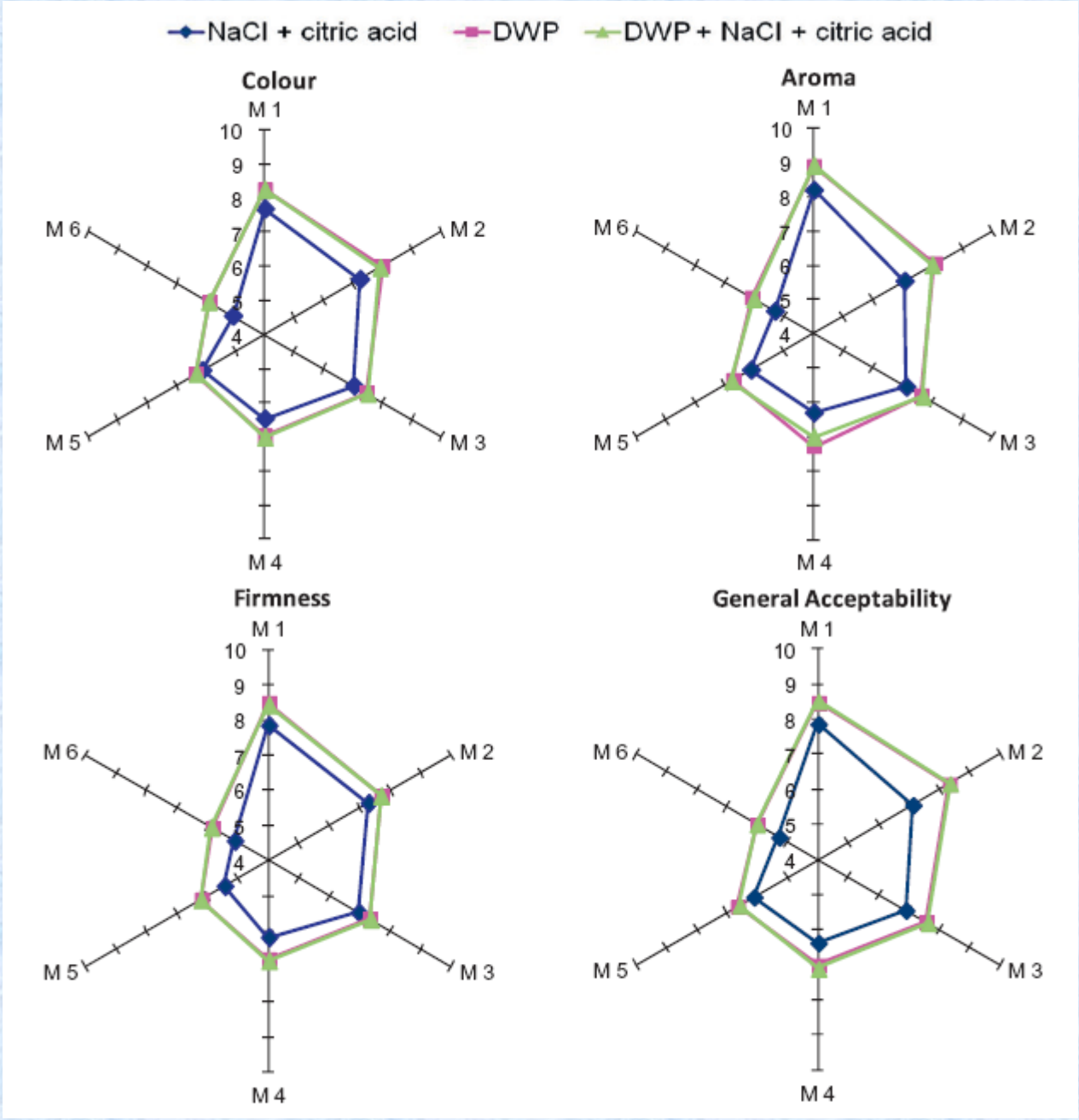
Changes in phytochemical content of canned Irish plum tomatoes added with delactosed permeate (DP) and/or NaCl+ citric acid for 6 months

Markers	Treatments	Significance of Difference	Storage (Months) 0	1	2	3	4	5	6
Ascorbic Acid (mg/100 g DW)	NaCl+ Citric Acid	A	130.81^{g}	122.12^{f}	114.7^{de}	109.05^{d}	101.22^{c}	95.983^{b}	91.0^{a}
	DP	B	141.4^{h}	133.9^{g}	128.4^{fg}	122.6^{f}	117.5^{e}	112.9^{de}	108.2^{d}
	DP + NaCl+ Citric Acid	C	143.51^{h}	139.78^{gh}	135.62^{g}	129.15^{fg}	122.317^{f}	115.38^{de}	111.76^{de}
Lycopene (mg/100 g DW)	NaCl+ Citric Acid	A	108.3^{b}	107.8^{b}	105.5^{ab}	106.6^{b}	104.7^{ab}	102.8^{a}	104.1^{ab}
	DP	B	120.2^{d}	116.5^{cd}	115.8^{cd}	113.3^{c}	115.8^{cd}	115.5^{cd}	114.0^{c}
	DP + NaCl+ Citric Acid	C	125.3^{e}	123.3^{e}	122.0^{de}	122.7^{de}	121.8^{de}	121.2^{de}	121.0^{de}
Total Phenol (mg GAE/100 g DW)	NaCl+ Citric Acid	A	290.6^{a}	292.0^{ab}	294.7^{b}	295.2^{b}	297.8^{c}	298.8^{cd}	300.7^{d}
	DP	B	304.4^{e}	305.3^{e}	306.2^{e}	308.2^{f}	310.3^{g}	311.6^{gh}	312.4^{gh}
	DP + NaCl+ Citric Acid	C	305.3^{e}	306.2^{e}	307.4^{ef}	309.3^{f}	311.4^{gh}	312.1^{gh}	314.1^{h}
DPPH (% Inhibition)	NaCl+ Citric Acid	A	64.67^{e}	63.17^{de}	60.67^{d}	56.67^{c}	54.5^{b}	53.33^{b}	51.5^{a}
	DP	B	75.5^{fg}	72.67^{f}	71.00^{f}	68.0^{ef}	65.17^{e}	63.0^{de}	61.33^{d}
	DP + NaCl+ Citric Acid	C	80.33^{g}	79.0^{g}	77.33^{fg}	75.0^{fg}	73.5^{f}	71.17^{f}	67.17^{ef}
FRAP (mg Trolox/100 g DW)	NaCl+ Citric Acid	A	1197.3^{fg}	1182.5^{f}	1156.1^{e}	1104.5^{cd}	1064.7^{b}	1000.8^{ab}	983.8^{a}
	DP	B	1213.8^{g}	1203.8^{fg}	1187.8^{f}	1152.5^{e}	1124.0^{d}	1096.7^{c}	1052.3^{b}
	DP + NaCl+ Citric Acid	C	1216.5^{g}	1204.6^{fg}	1191.7^{f}	1168.8^{e}	1139.5^{d}	1110.7^{cd}	1089.2^{c}

Canned Tomatoes

Changes in texture and colour of canned tomatoes added with delactosed permeate (DP) and/or NaCl + citric acid stored for 6 months

Markers	Treatments	Significance of Difference	Storage (Months)						
			0	1	2	3	4	5	6
Texture (N)	NaCl+ Citric Acid	A	4.17^{fg}	3.52^{de}	3.19^{cd}	3.06^{c}	2.83^{b}	2.71^{ab}	2.53^{a}
	DP	B	5.09^{gh}	4.81^{g}	4.62^{g}	4.06^{f}	3.72^{e}	3.56^{de}	3.27^{d}
	DP + NaCl+ Citric Acid	C	5.45^{h}	5.35^{h}	4.82^{g}	4.33^{fg}	4.08^{f}	3.82^{e}	3.55^{de}
Colour									
L*	NaCl+ Citric Acid	A	22.20^{de}	21.95^{d}	21.36^{c}	21.16^{c}	20.78^{bc}	20.37^{b}	19.58^{a}
	DP	B	24.82^{fg}	24.84^{fg}	24.14^{f}	23.32^{e}	22.72^{de}	22.22^{de}	21.76^{d}
	DP + NaCl+ Citric Acid	C	25.50^{g}	24.47^{f}	24.19^{f}	23.44^{e}	23.08^{e}	22.62^{de}	22.12^{d}
a*	NaCl+ Citric Acid	A	9.49^{c}	9.26^{bc}	9.07^{bc}	8.80^{b}	8.64^{b}	8.41^{b}	8.01^{a}
	DP	B	12.80^{f}	12.47^{ef}	12.31^{e}	12.10^{de}	12.06^{de}	11.84^{d}	11.75^{d}
	DP + NaCl+ Citric Acid	C	13.08^{f}	12.91^{f}	12.73^{f}	12.62^{ef}	12.55^{ef}	12.41^{e}	12.22^{e}
b*	NaCl+ Citric Acid	A	23.58^{d}	23.29^{c}	23.18^{c}	22.82^{bc}	22.62^{b}	22.45^{b}	22.23^{a}
	DP	B	25.09^{fg}	24.62^{f}	24.33^{ef}	24.10^{e}	23.79^{de}	23.60^{d}	23.29^{c}
	DP + NaCl+ Citric Acid	C	25.87^{h}	25.55^{g}	25.31^{fg}	25.07^{fg}	24.80^{f}	24.72^{f}	24.46^{ef}
Hue	NaCl+ Citric Acid	A	68.07^{c}	68.32^{c}	68.62^{cd}	68.92^{d}	69.10^{e}	69.47^{ef}	70.19^{f}
	DP	B	62.97^{a}	63.13^{ab}	63.16^{ab}	63.34^{b}	63.11^{ab}	63.36^{b}	63.24^{ab}
	DP + NaCl+ Citric Acid	C	63.18^{ab}	63.19^{ab}	63.30^{ab}	63.28^{b}	63.16^{ab}	63.34^{b}	63.45^{b}
Chroma	NaCl+ Citric Acid	A	25.42^{cd}	25.07^{c}	24.89^{c}	24.46^{bc}	24.21^{bc}	23.98^{b}	23.63^{a}
	DP	B	28.17^{fg}	27.59^{f}	27.26^{ef}	26.96^{e}	26.67^{de}	26.41^{de}	26.08^{d}
	DP + NaCl+ Citric Acid	C	28.99^{g}	28.62^{g}	28.33^{fg}	28.07^{fg}	27.79^{f}	27.66^{f}	27.34^{e}


NaCl + citric acid
DWP
DWP + NaCl + citric acid
Colour
Aroma
Firmness
General Acceptability
M 1
M 2
M 3
M 4
M 5
M 6
10
9
8
7
6
5
4

Strawberries

Washing strawberries

Drying strawberries

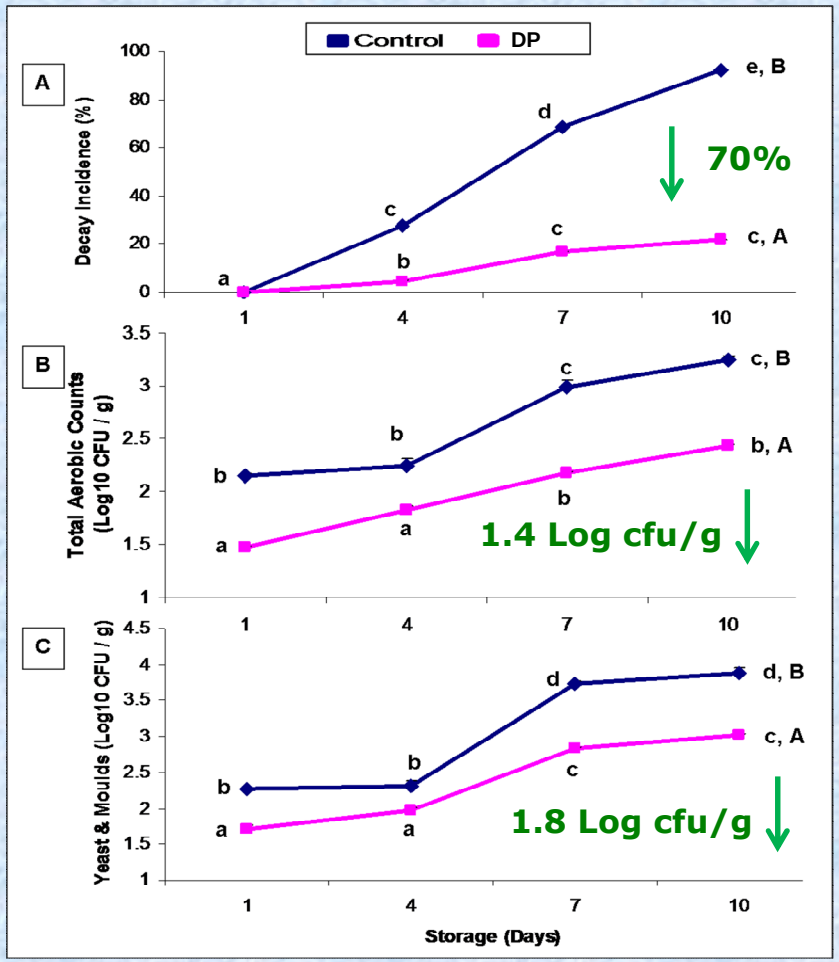
Strawberry packages

Strawberries in storage

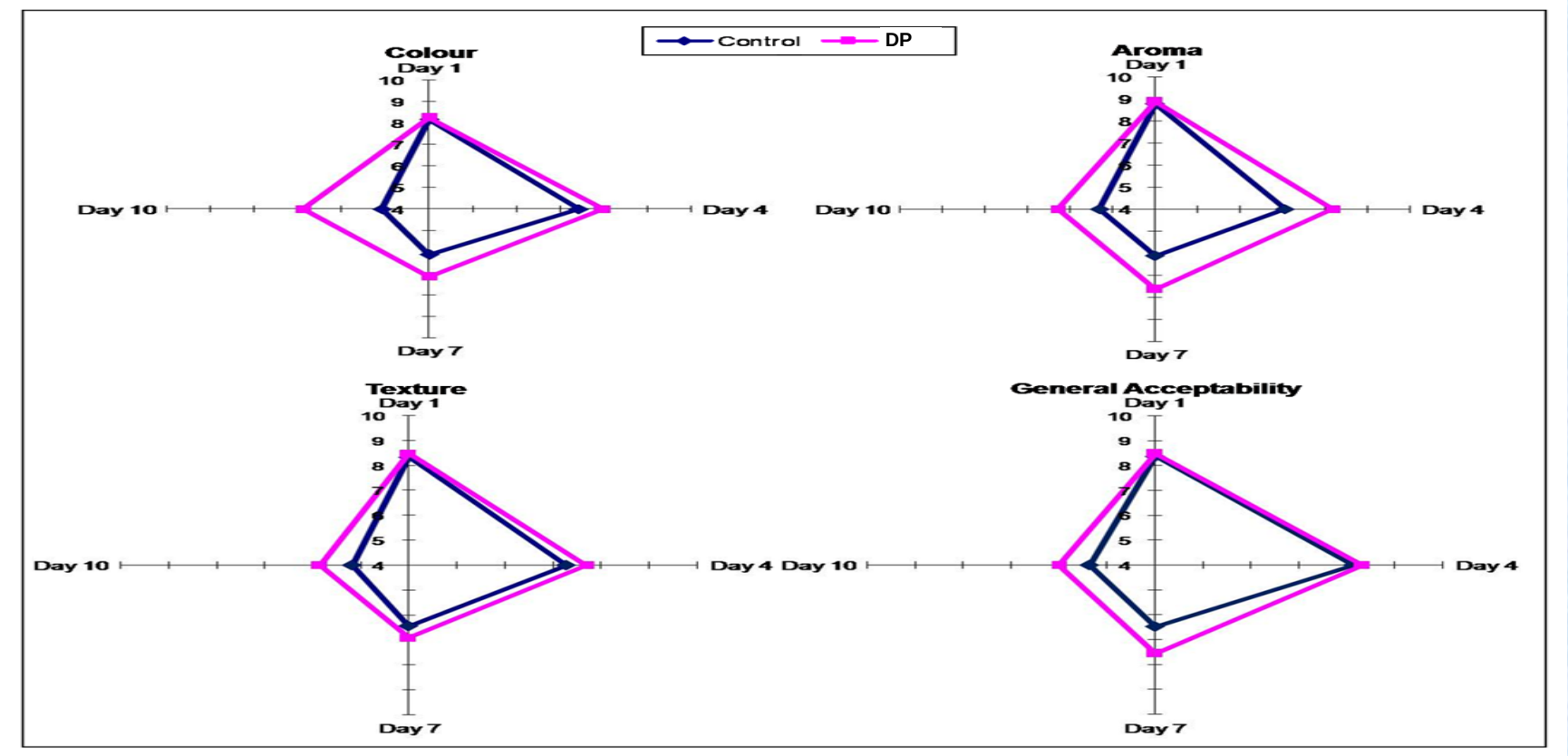
Processing steps for fresh strawberries

Strawberries

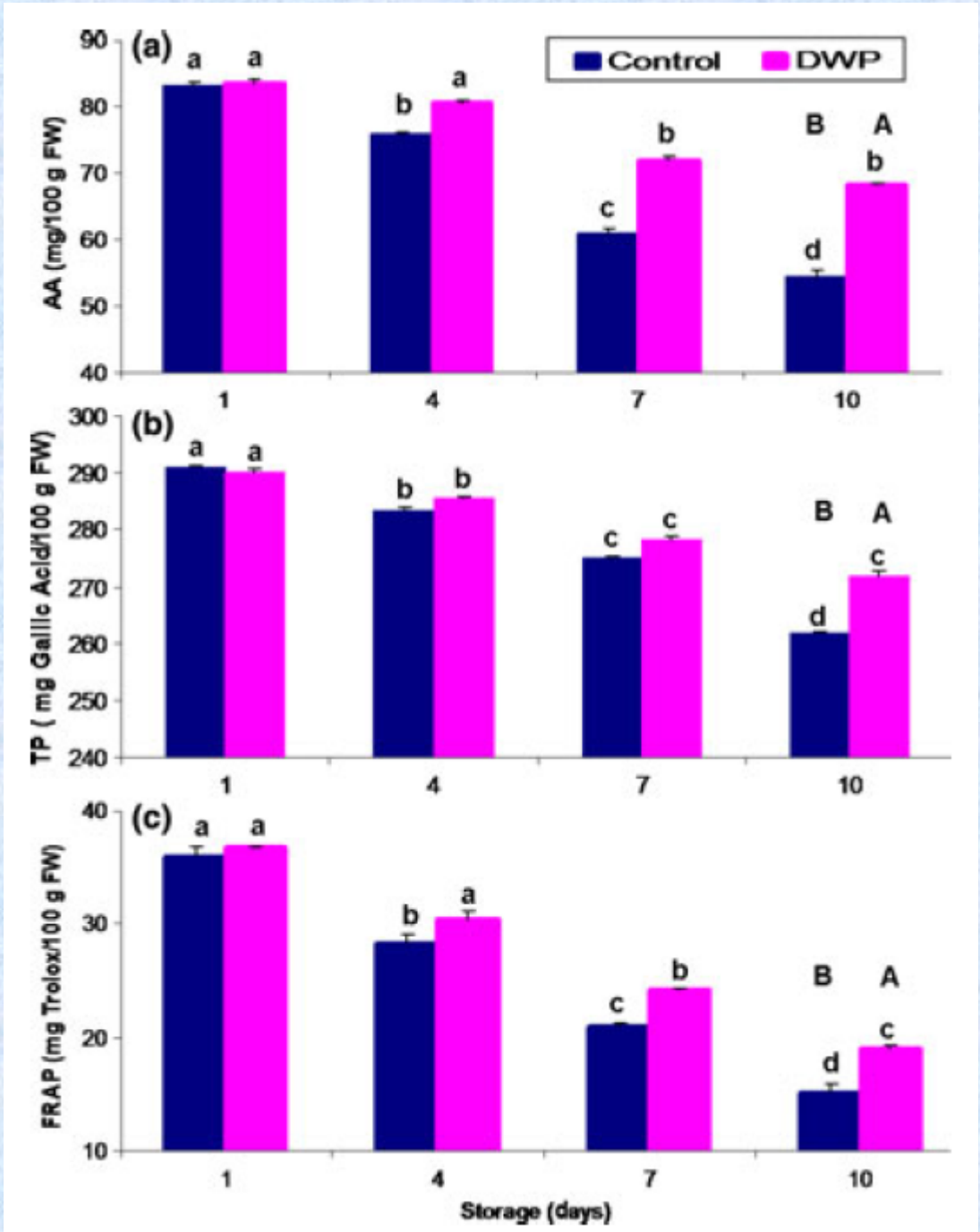
Effect of whey delactosed permeate (DP) treatment on (A) decay incidence, (B) total aerobic counts and (C) yeast and moulds of strawberries during 10 days of storage at 4 °C



Strawberries



Sensory evaluation of strawberries treated with whey delactosed permeate (DP) and compared with control (washed with distilled water) samples at 4 °C for 10 days of storage


(a)
Control
DWP
AA (mg/100 g FW)
90
80
70
60
50
40
a a
b a
c b
d b
B A
1
4
7
10
(b)
TP (mg Gallic Acid/100 g FW)
300
290
280
270
260
250
240
a a
b b
c c
d c
B A
1
4
7
10
(c)
FRAP (mg Trolox/100 g FW)
40
30
20
10
a a
b a
c b
d c
B A
1
4
7
10
Storage (days)

Conclusion

- Whey permeate possesses valuable components & functional properties.
- Delactosed permeate (DP) had significantly better results.
- Whey permeates performed better or similar to the industrial standard chlorine in retaining the quality of fresh-cut tomatoes.
- DP significantly reduced the decay incidence, lowered the growth of microbial population and maintained overall quality & antioxidant components of whole tomatoes and strawberries.
- DP significantly retained the phytochemical content and maintained firmness of canned tomato.
- The presence of anti-microbial peptides (caseinmacropeptide or bacteriocins) in DP might contribute to its anti-microbial capacity.
- Therefore, DP treatment could be used as a potential preserving agent for fresh-cut, whole and processed fruits and vegetable products to extend the shelf-life and maintain the nutritional quality during storage.

SEVENTH FRAMEWORK PROGRAMME

WHEYSAN

whey based formula

http://www.contactica.es/wheysan/index.php

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