

# Recovery of glycoalkaloids from potato peels and effect of storage conditions on the glycoalkaloid content of five Irish grown potato cultivars

Mohammad B. Hossain, Nigel Brunton, Dilip Rai

Teagasc Food Research Centre, Ashtown  
University College Dublin

# Background

- ❑ Glycoalkaloids in potato are potentially toxic compounds
- ❑ A maximum recommended level of glycoalkaloid in potato is 1 mg/g DW (USDA) (Bejarano et al. 2000)
- ❑ 1 mg/kg body weight (BW) per individual
- ❑ Symptoms include nausea, vomiting, diarrhea, stomach and abdominal cramps, headache, fever, rapid and weak pulse, rapid breathing, hallucinations, delirium (Friedman and McDonald, 1997).
- ❑ Effects on the nervous system include increased heart, pulse, and respiratory rates, sedation, and coma (Zeiger, 1998).
- ❑ Alpha-chaconine and alpha-solanine are found within the tuber, are heat stable, and are not degraded from cooking or frying as they begin to degrade between 230 and 280 °C (Bejarano et al., 2000).

# Background

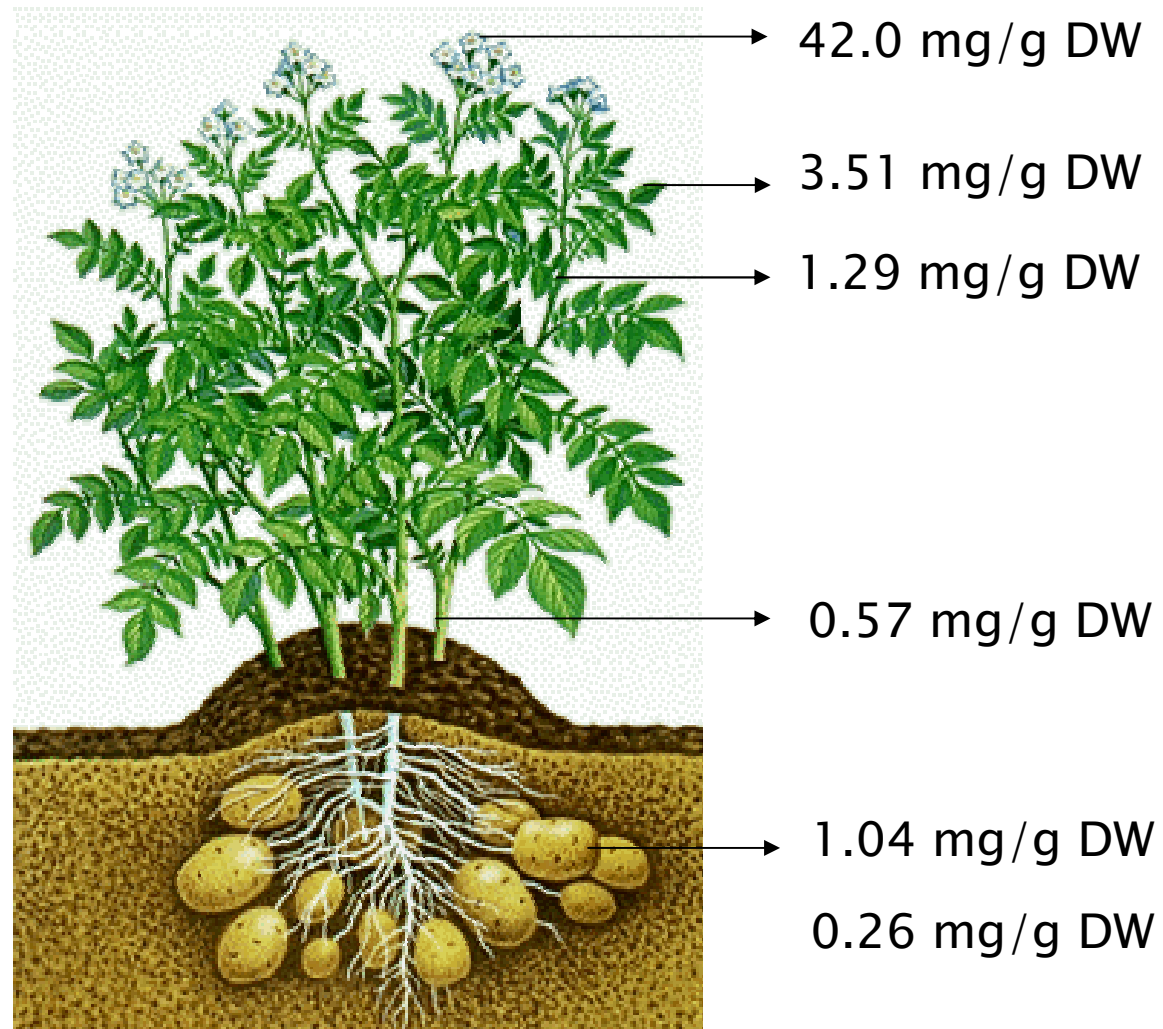
- ❑ Potato glycoalkaloids are anticarcinogenic, anti-inflammatory and anti-microbial
- ❑ Highly potential compounds to be used in phytopharmaceutical industries
- ❑ However, potato glycoalkaloids are also toxic to normal cells, ie., necrotic
- ❑ Structural modification of the potato glycoalkaloids could show apoptosis in cancer cell lines
- ❑ Structural modifications require large quantity of pure glycoalkaloids particularly aglycone alkaloid solanidine

# Background

- ❑ Potato glycoalkaloids were also effective in controlling soil nematodes in potato field as observed in our study
- ❑ Potato peels: easily accessible, cheap source
- ❑ If utilized, will be useful for waste management in potato based industries



## Anatomical distribution of glycoalkaloids in potato plant



# Changes of glycoalkaloid content in potato berries with maturity



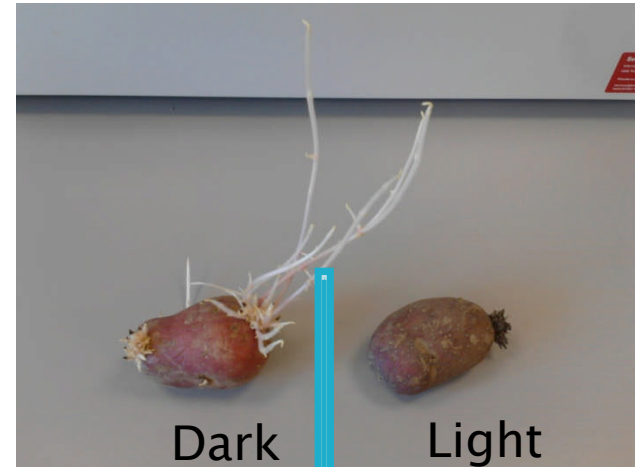
8.30 mg/g DW



4.86 mg/g DW



4.7 mg/g DW



28 mg/g DW

## Glycoalkaloid content in different part of the berries

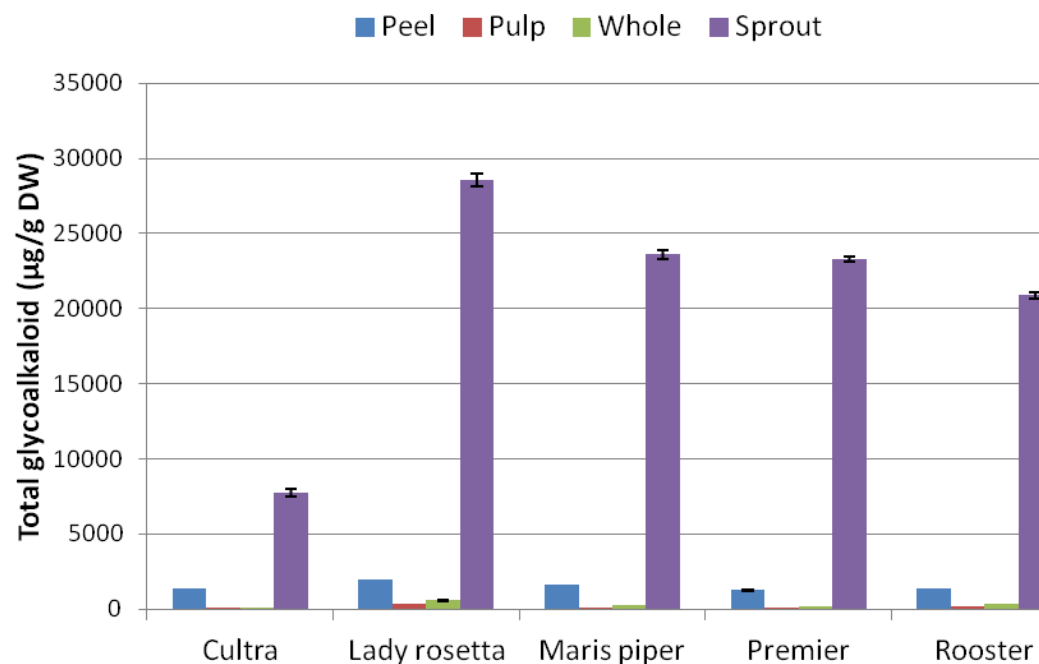


Stalk: 6.38 mg/g DW

Pulp: 4.64 mg/g DW

Peel: 2.91 mg/g DW

# Glycoalkaloid content in different anatomical locations of potato tubers

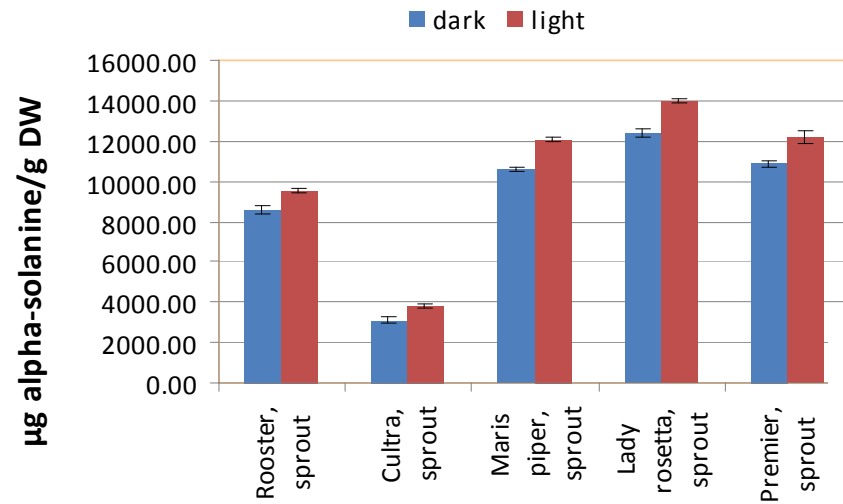


Sprouts of Lady rosetta had 14 times higher glycoalkaloids than peels after 30 days of storage



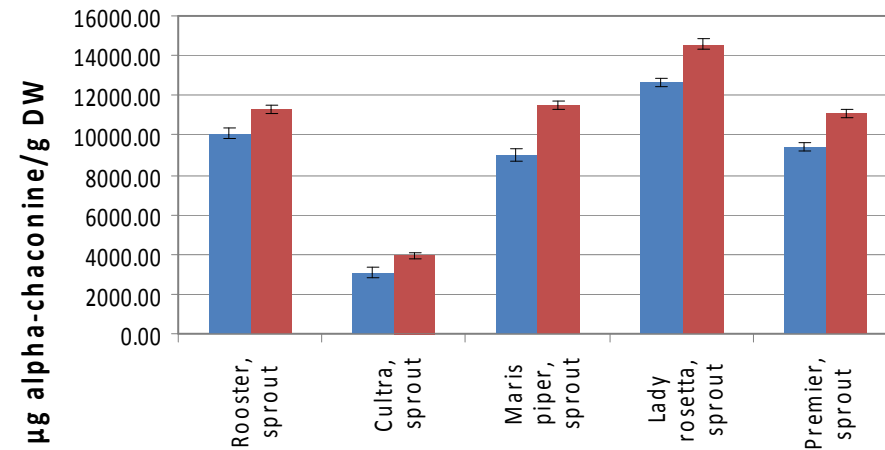
# Glycoalkaloids in potato sprouts

## Sprout at D-90

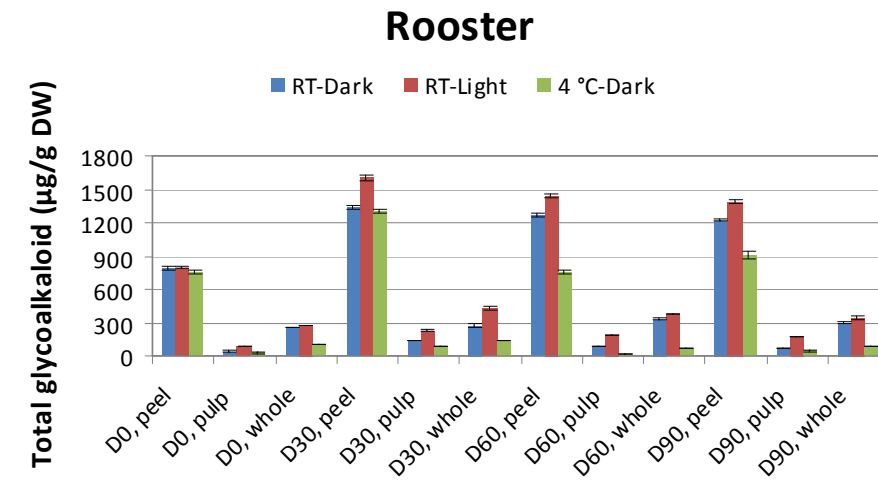
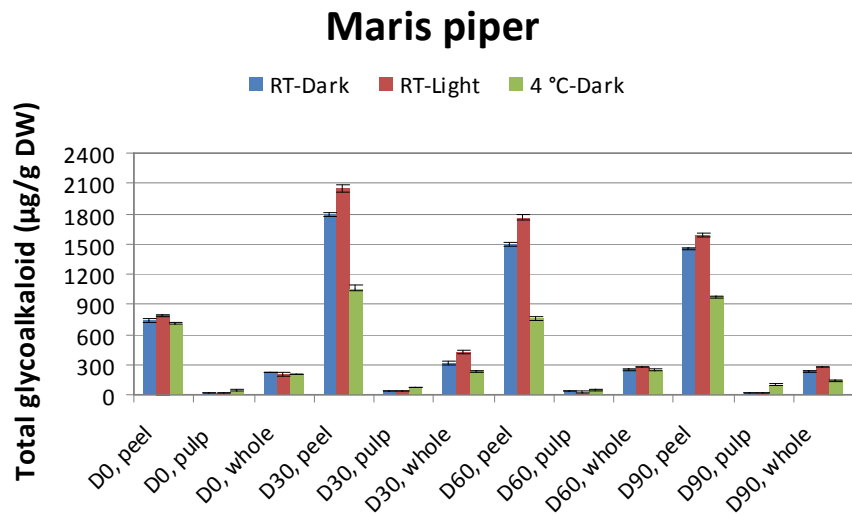
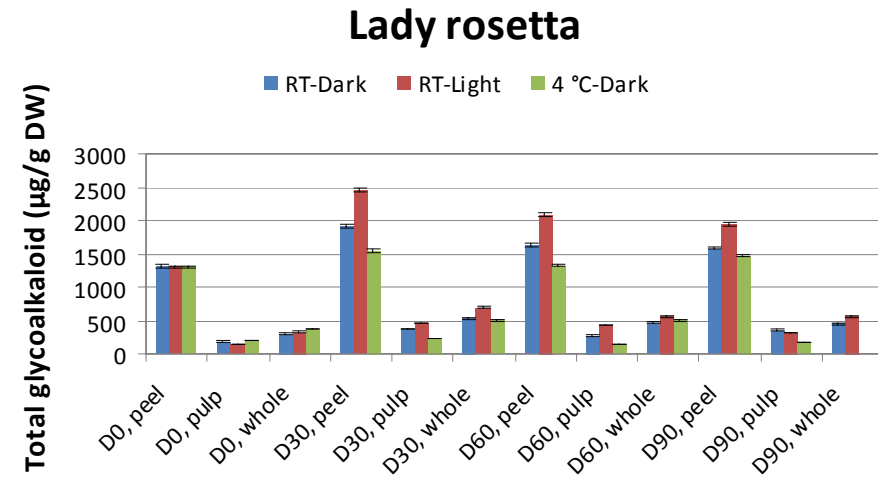
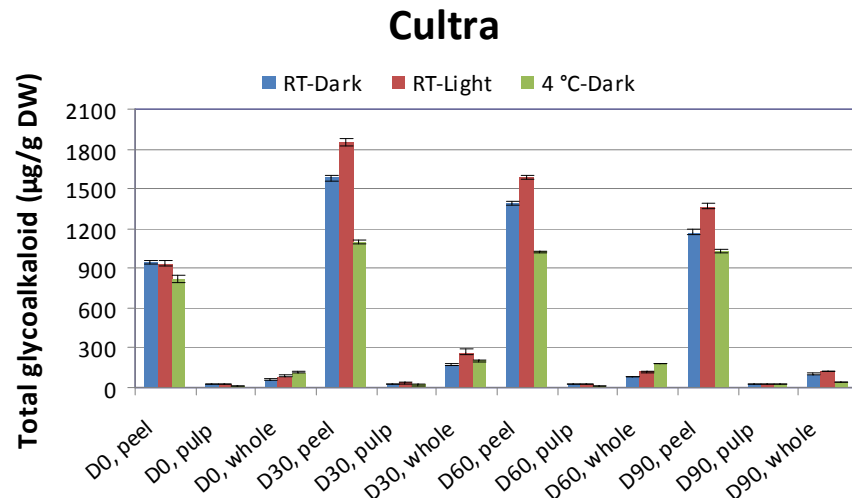


Sprout at D-90

■ dark ■ light



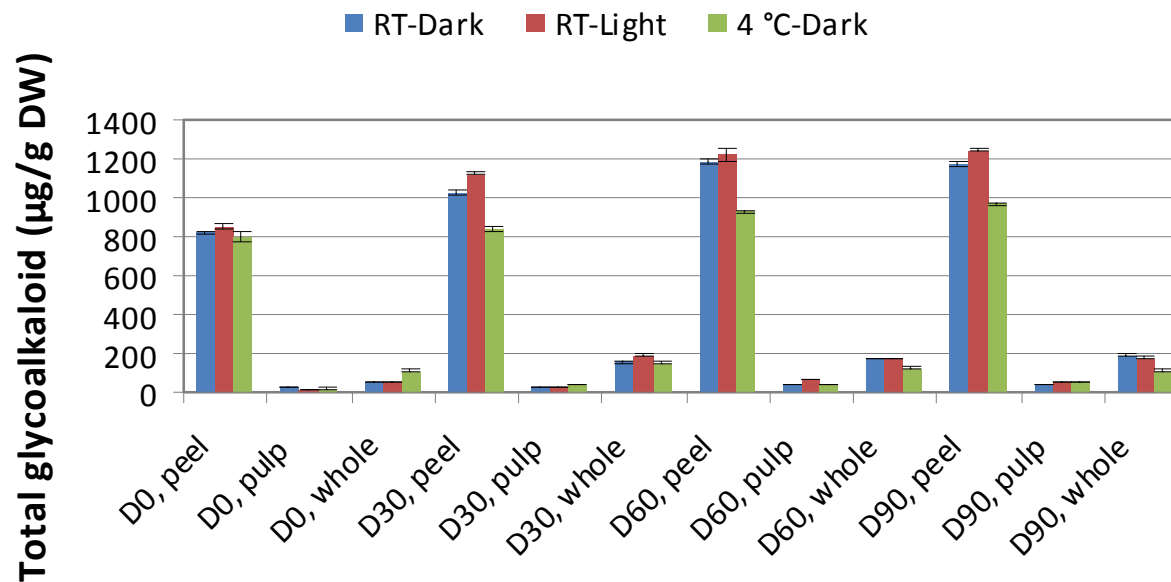
# Effect of storage condition on the glycoalkaloid content of different potato cultivars



- Accumulation of glycoalkaloids peaked at 30 days of storage
- RT-light > RT-dark > 4 °C-dark

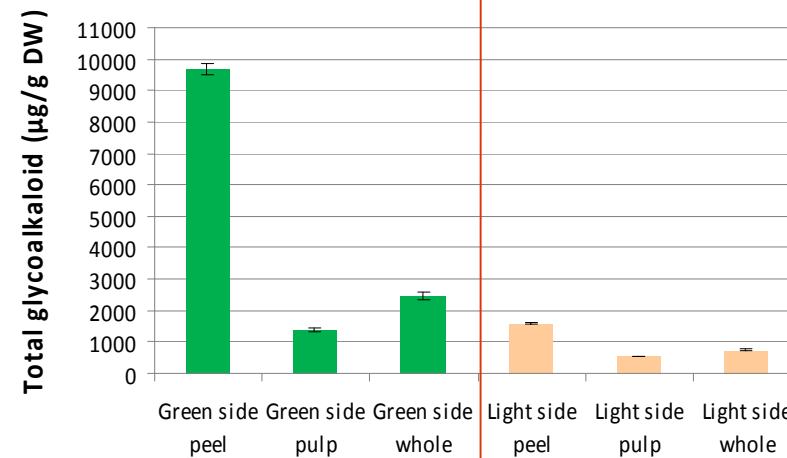
# Effect of storage condition on the glycoalkaloid content of different potato cultivars

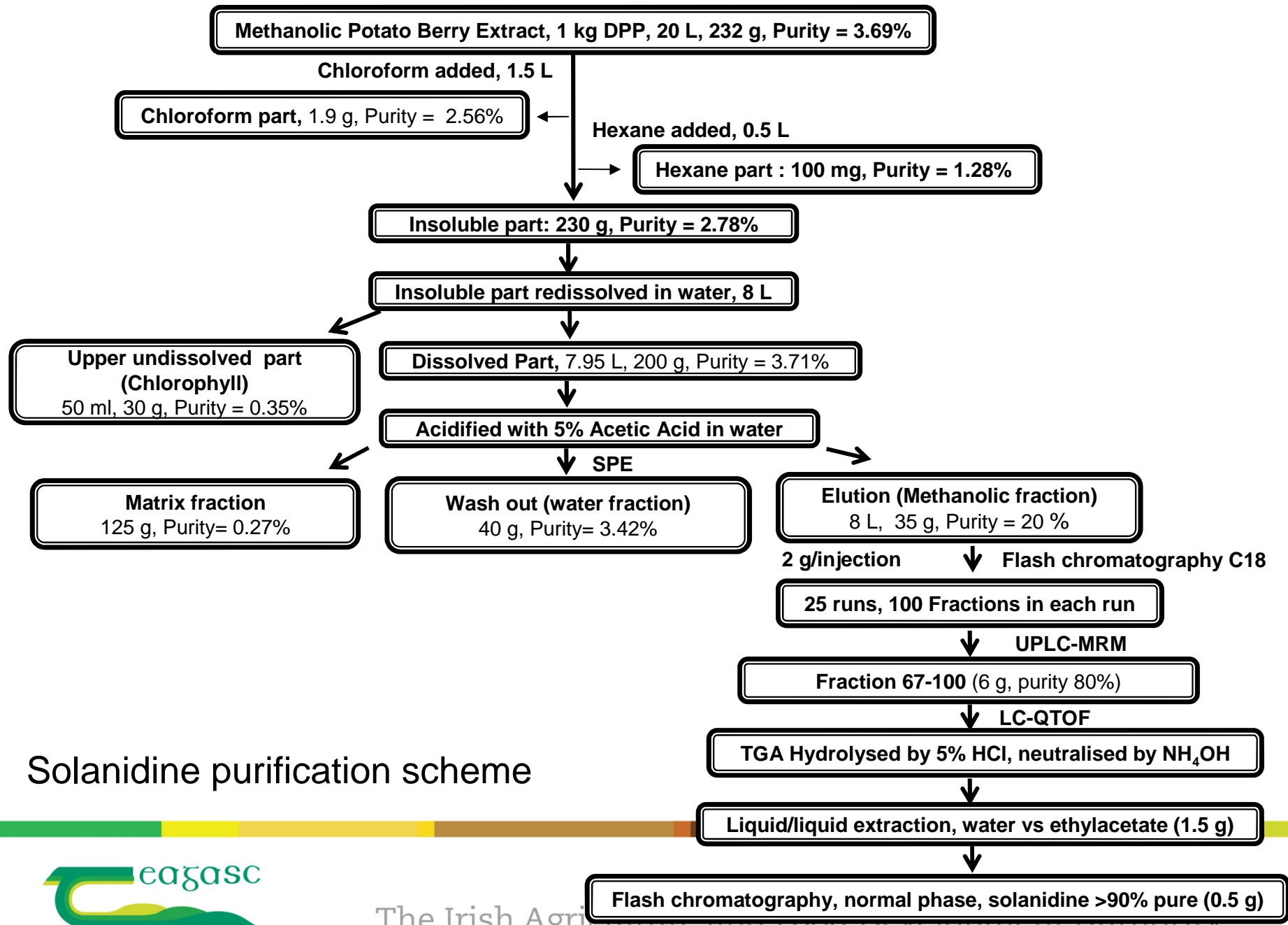
## Premier



Contrary to other cultivars, Premier had gradual increase of glycoalkaloids until 90 days of storage

# Localisation of glycoalkaloid synthesis



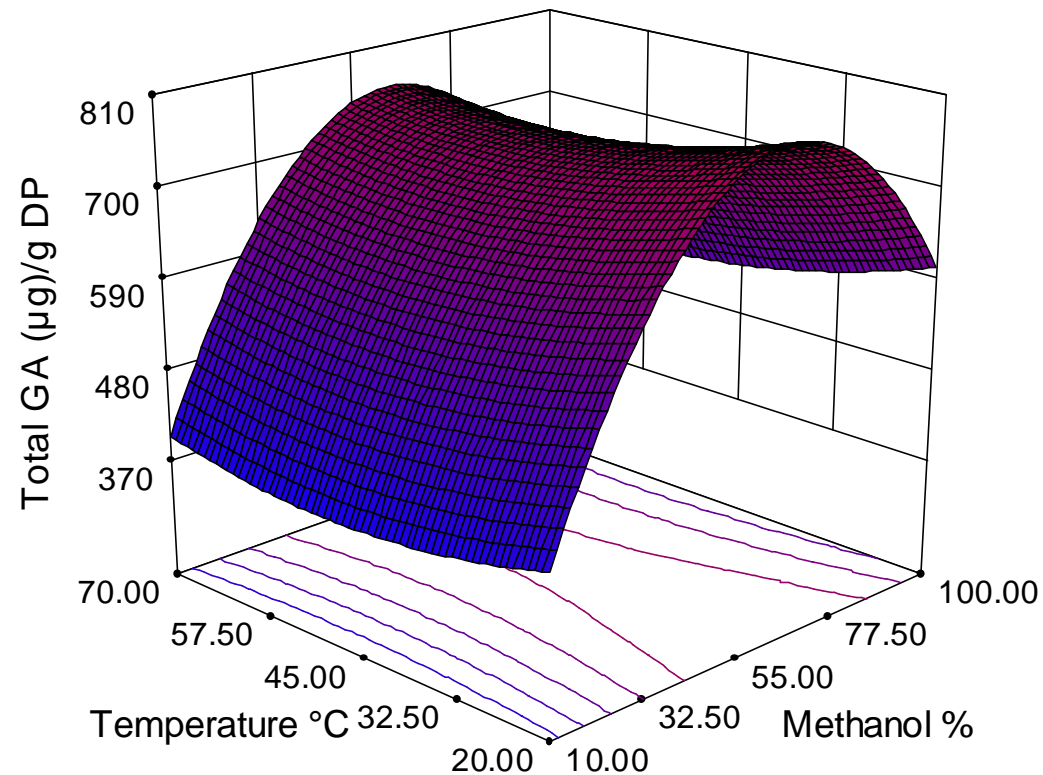


Solanidine purification scheme

## Concentrations of different glycoalkaloids in extracts obtained by different solvents

Extracts obtained by 1 g dried potato peel (DPP) in 40 ml for 48 h	$\alpha$ -Solanine	$\alpha$ -Chaconine	Solanidine	Demissidine	Total	Extraction yield (mg/ g DPP)	Total glycoalkaloid ( $\mu$ g/g DPP) (Purity %)	Ranking (Price/L)
	( $\mu$ g/mg dried extract)							
<b>Tetrahydrofuran</b>	<b>0.263</b>	<b>2.55</b>	<b>0.967</b>	<b>0.135</b>	<b>3.91</b>	<b>47.2</b>	<b>184.79 (0.39)</b>	<b>6 (112 €)</b>
<b>Methanol</b>	<b>4.29</b>	<b>3.275</b>	<b>2.404</b>	<b>0.152</b>	<b>10.12</b>	<b>75.2</b>	<b>761.10 (1.01)</b>	<b>2 (20.8 €)</b>
<b>Ethylacetate</b>	<b>0.137</b>	<b>0.027</b>	<b>1.398</b>	<b>0.137</b>	<b>1.69</b>	<b>38.4</b>	<b>65.24 (0.17)</b>	<b>10 (50 €)</b>
<b>Chloroform</b>	<b>0.144</b>	<b>0.029</b>	<b>1.86</b>	<b>0.145</b>	<b>2.17</b>	<b>23.2</b>	<b>50.53 (0.22)</b>	<b>11(74 €)</b>
<b>Acetonitrile</b>	<b>0.138</b>	<b>0.031</b>	<b>1.17</b>	<b>0.135</b>	<b>1.47</b>	<b>34.4</b>	<b>50.71 (0.15)</b>	<b>12(110 €)</b>
<b>Acetone</b>	<b>0.173</b>	<b>2.301</b>	<b>1.718</b>	<b>0.145</b>	<b>4.33</b>	<b>31.2</b>	<b>135.31 (0.43)</b>	<b>8(51 €)</b>
<b>Iso-propanol</b>	<b>1.005</b>	<b>1.86</b>	<b>0.944</b>	<b>0.128</b>	<b>3.93</b>	<b>49.6</b>	<b>195.28 (0.39)</b>	<b>5(44 €)</b>
<b>Ethanol</b>	<b>4.063</b>	<b>3.898</b>	<b>1.487</b>	<b>0.139</b>	<b>9.58</b>	<b>41.6</b>	<b>398.82 (0.96)</b>	<b>4(51 €)</b>
<b>Dichloromethane</b>	<b>0.855</b>	<b>0.309</b>	<b>0.677</b>	<b>0.129</b>	<b>1.97</b>	<b>40.8</b>	<b>80.38 (0.20)</b>	<b>9(48 €)</b>
<b>Tetrahydrofuran + Water + Acetonitrile (50:30:20)</b>	<b>5.285</b>	<b>3.466</b>	<b>2.805</b>	<b>0.162</b>	<b>11.71</b>	<b>102.4</b>	<b>1199.92 (1.17)</b>	<b>1(95 €)</b>
<b>Water</b>	<b>0.693</b>	<b>0.027</b>	<b>0.542</b>	<b>0.122</b>	<b>1.384</b>	<b>101.6</b>	<b>140.61 (0.14)</b>	<b>7(40 €)</b>
<b>5 % Acetic acid</b>	<b>2.98</b>	<b>1.54</b>	<b>0.687</b>	<b>0.124</b>	<b>5.331</b>	<b>138.4</b>	<b>737.81 (0.53)</b>	<b>3(45 €)</b>

# Optimisation of SLE parameters



**61% methanol,  
20 °C and 240 min**

# Application of novel processing to enhance glycoalkaloid extraction

UAE at 61 $\mu\text{m}$ and 17 min	SLE using 100% methanol for 17 min	PEF using 0.75 kV/cm for 600 $\mu\text{s}$	SLE using 100% methanol for 60 min	PL at fluences of 8 J/cm <sup>2</sup>	SLE using 100% methanol for 60 min	PLE at 80 °C and 90% methanol	SLE using 90% methanol for 60 min
<b>Total glycoalkaloid content (<math>\mu\text{g/g DW}</math>)</b>							
1102 $\pm$ 1.02	710.5 $\pm$ 6.0	1856.18 $\pm$ 17.9	928.49 $\pm$ 27.7	1108.96 $\pm$ 23.7	852.26 $\pm$ 15.9	1950 $\pm$ 30.2	881 $\pm$ 11.3

PLE > PEF > PL > UAE > SLE

PLE = Pressurised liquid extraction

PEF = Pulsed electric field assisted extraction

PL = Pulsed light assisted extraction

UAE = Ultrasound assisted extraction

SLE = Solid-liquid extraction



# Conclusion

- ❑ Abundance of potato peels makes them suitable source of glycoalkaloids
- ❑ 100% methanol should be used as solvent from purification point of view
- ❑ Chromatographic procedure needs further improvement
- ❑ Potato peels should be avoided for consumption
- ❑ Storage should be at 4 °C-dark
- ❑ PLE and PEF are the promising novel extraction techniques

# Acknowledgements

- Food Institutional Research Measure, DAFM
- Largo Foods
- Wilson's Country Limited
- Colleagues of Ashtown and UCC



Thank you for your attention