About this document

These proceedings have been designed to be printed as a book with A5 pages. Following a widely used convention in book publishing, each section starts on an odd numbered or recto\(^1\) page. The sections in these proceedings are:

- Foreword
- Table of Contents
- The themed sessions of the conference:
  - Health and Nutrition
  - Climate Change
  - Social and Cultural Contexts
  - Disease Resistance
  - Genetic Modification
  - Economic Policy

This means that there are blank pages in the electronic version of the document, therefore double sided printing is recommended.

Using Adobe Acrobat / Acrobat Reader you can print out pages at A4 size.

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\(^{1}\) Recto; right-hand page of an open book - The normal side to start a story or chapter (http://www.writersservices.com/wps/p_glossary_%20printing.htm).
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Foreword

Welcome to the Universitas 21 Graduate Research Conference on Food, hosted by the University of Nottingham Malaysia Campus. This publication contains the papers presented, by research students from universities across the U21 network, during the four-day conference in Kuala Lumpur in June 2011.

The conference theme of food is both timely and relevant and the Malaysian venue is an ideal one for discussion of this nature, given the breadth and wealth of biodiversity and relevant expertise in the region.

Production, sustainability and the global impact of food development represents a critical area of research and one that initiatives such as this conference are driving forwards.

The overarching subject of food is cross-disciplinary in nature and the papers published in these proceedings are testament to the diversity of interest, expertise and potential collaboration that exists across the U21 network.

The proceedings are divided according to the themed sessions of the conference:

- Health and Nutrition
- Climate Change
- Social and Cultural Contexts
- Disease Resistance
- Genetic Modification
- Economic Policy

This publication clearly demonstrates the high level of research and investigation underway and fully supports the need for continued discussion, research and development in an area that is of dramatic and immediate relevance to this generation and will impact the very survival of those to come.

The University of Nottingham Graduate School
University of Nottingham Malaysia Campus

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Health and Nutrition

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Exploiting nutritional effects of whey proteins to develop food with health benefits

Ulrika Gunnerud
Lund University

Summary
Food and nutrition has to be considered in the treatment of many diseases. Whey proteins have been found to be very insulin stimulating, a quality needed in treatment of diabetes type 2. A dose response study was executed to investigate the effect of whey proteins on blood glucose regulation. The result demonstrated that whey proteins stimulate the insulin release and facilitate blood glucose regulation after glucose ingestion in healthy humans in a dose- response dependent manor. It can be suggested that whey proteins may be used as a meal complement to facilitate the blood glucose regulation. A possible application of whey proteins is to develop new foods that are beneficial for both healthy subjects as for patients with diabetes type 2.

Introduction
Diet related diseases, like obesity and type 2 diabetes (T2D) are an increasing problem world-wide, as is the cost for the treatment of these diseases. Obesity used to be a problem in high income countries, but is now also a fact in low- and middle- income countries. This call for low cost actions and preventive efforts, and the development of “food-derived drugs” or food with healthy benefits may be a part of the solution. Food can be a part of the treatment and it would benefit both the patients and the society, since advantages will be seen in both increased public health as in economic savings.

A complication with obesity and T2D is insulin resistance that causes frequently occurring episodes with high blood glucose levels. High blood glucose levels are being associated with oxidative stress and increases the risk of cardiovascular diseases in T2D patients. A well regulated blood glucose regulation is essential
Ulrika Gunnerud  
Exploiting nutritional effects of whey proteins to develop food with health benefits

to reduce complications in T2D and, in addition, it can be expected to postpone onset of this disease in ‘at risk’ subjects.

The insulin stimulating potential of various food proteins has been examined, and in previous studies it has shown that adding whey proteins to a meal reduce blood glucose excursions after a meal in both healthy subjects and in patients with T2D (Nilsson et al, 2004, Frid et al, 2005). Certain food proteins and/or amino acids stimulate insulin release, similarly to insulin stimulating drugs, thus facilitating normalization of the blood glucose levels in type 2 diabetic and in glucose intolerant subjects. The aim of this study was to evaluate the insulinotropic effects of whey proteins in a dose response setting with focus on glycaemic and insulinaemic responses.

**Material and methods**

An acute meal study was executed and three different whey doses (18, 9 or 4.5g proteins) were evaluated in healthy subjects. Spray-dried whey protein powder was dissolved in 250g of water and served as breakfast. Pure glucose was used as a reference drink and all test drinks contained 25g glucose. Blood samples were taken at fasting and at 15, 30, 45, 60, 90 and 120 min after the breakfast for analysis of blood glucose, serum insulin and free amino acids in plasma.

**Results and discussion**

A linear dose-dependent relation was found on both blood glucose and insulin at AUC 120 (glucose: $r=-0.457$, $P=0.001$; insulin: $r=0.420$, $P=0.003$). In table 1 the glycaemic index and insulinaemic index at AUC 120 min is displayed. The GI’s of 18g and 9g whey (61 and 70, respectively) were significant lower compared to the GI of the reference drink (100).
Table 1: GI and II for AUC 0-120 min

<table>
<thead>
<tr>
<th>Product</th>
<th>n</th>
<th>GI 120 ± SEM</th>
<th>II 120 ± SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>12</td>
<td>100&lt;sup&gt;a&lt;/sup&gt;</td>
<td>100&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>18g whey</td>
<td>12</td>
<td>61 ± 9.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td>187 ± 20.47&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>9g whey</td>
<td>12</td>
<td>70 ± 8.78&lt;sup&gt;b&lt;/sup&gt;</td>
<td>136 ± 17.77&lt;sup&gt;abc&lt;/sup&gt;</td>
</tr>
<tr>
<td>4.5g whey</td>
<td>11</td>
<td>85 ± 11.51&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>151 ± 20.82&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

A significant treatment × time was also found. At 45 min, the 9g dose was significantly higher than the reference. However, there were no differences between the lowest dose 4.5g, in relation to the reference or any of the other two doses. In figure 1 the incremental changes in blood glucose and serum insulin are displayed. Although not statistically different, there was a clear trend that even the lowest whey dose elicits a lower glucose response than the reference.

All three whey doses resulted in higher insulinemic indices (II) than the reference, but only 18g and 4.5g were significantly higher. However, the 9g dose tended to cause a higher insulin area than the reference in the early post-prandial phase (0-45 min). The insulin response after the 18 g dose was significantly higher than all the other test meals.
Figure 1: Mean (± SEM) incremental changes (Δ) in blood glucose and insulin

As seen in figure 1, there is no obvious dose response pattern on the II since 9g of whey results in a lower AUC than the 4.5g does. The reasons for this discrepancy seem to derive from a few odd
insulin responses at the 9 g dose combined with a low participant number (12) in the study. Thus each personal insulin response has a big statistical impact. Both the 18g and 9g doses had more rapid insulin increases at 0-30 min compared to the reference drink, whilst 4.5g of whey had a curve that matched that of the reference. Interestingly, even though the 4.5g dose was so similar to the reference response, they were statistically different at 90 and 120 min. This can be interpreted as an indication that even low doses of whey may be enough to achieve an insulinotrophic effect.

**Conclusions**

In the present study a clear dose-response correlation was found between whey intake and blood glucose. Low doses of whey proteins potentiate insulin release and facilitate blood glucose regulation after glucose ingestion in healthy humans. This is an interesting characteristic that can be used to develop new food with benefits on the glycaemic regulation. A blood glucose lowering effect was found with as low doses as 4.5 g whey proteins, suggesting that whey protein is very “applicant friendly” for new food products, food that provides health benefits and sustainable growth by preventing obesity and T2D.

**References**


A low Glycaemic Index (GI) diet is an effective, under-utilized tool in the management of type 1 diabetes mellitus (T1DM)

Janice Wiley
University of New South Wales

Introduction
Type 1 Diabetes Mellitus (T1DM) gives rise to an absolute deficiency of insulin secretion due to cellular-mediated autoimmune destruction of the pancreatic β-cells. T1DM accounts for 5% to 10% of all diabetes mellitus cases worldwide. However, there is significant geographical variation in the incidence of T1DM. Thus, a child in Finland is 40 times more likely to develop T1DM than a child in Japan and almost 100 times more likely to get the disease than a child in the Zunyi region of China. (EURODIAB ACE 2000) In absolute numbers of people with T1DM worldwide, 24% come from South East Asia and 23% from Europe. (IDF 2010)

The incidence of T1DM is increasing worldwide by 3% every year. (Onkamo 1999, IDF 2010) The reasons for this are unknown. The increase is occurring in both low and high incidence populations. Finnish modeling predicted that by 2010 the incidence would be 50 per 100,000 a year in Finland and in many other populations it has exceeded 30 per 100,000 a year. (EURODIAB ACE 2000) The incidence in lower socio-economic counties is increasing more rapidly than in higher socio-economic countries. (IDF 2010)

Self-management of T1DM
T1DM is the quintessential self-managed disease. The effective self-management of T1DM is assessed by the achievement of a target glycated haemoglobin level of less than 7.0% in adults and 7.5% in children. (NICE 2010) However, control is difficult to achieve and diabetes disease-related micro-vascular and macro-vascular complication rates remain unacceptably high. Premature mortality is linked to diabetes related macro-vascular disease. (Lawson 1999) T1DM therefore
A low Glycaemic Index (GI) diet is an effective, under-utilized tool in the management of type 1 diabetes mellitus (T1DM) contributes to a significant burden of disease worldwide. (IDF 2010)

**Glycaemic Index (GI)**
Glycaemic Index (GI) is a ranking of foods based on their glycaemic impact on blood glucose levels compared to the reference standard, glucose. (Wolever 1991) Glycaemic load (GL) is a method of predicting the post-prandial blood glucose response to a portion size of food. (Salmeron 1997) Carbohydrates with a low GI result in a slower and more gradual rise in blood glucose levels, and reduce the post-prandial glycaemic response compared to carbohydrates with a higher GI. (Wolever 1991; Gilbertson 2003) Low-GI food sources include foods based on whole-grains such as oats, barley and quinoa; legumes and pulses; pasta, many fruits (temperate, citrus, most stone fruit and berries); and dairy foods. (Salmeron 1997; Gilbertson 2003) As well, low-GI diets are usually high in dietary fibre. (Salmeron 1997) Many factors may influence a food’s glycaemic response; however, the ranking of foods on the basis of their GI value is generally consistent. (Gilbertson 2003)

**The use of GI in T1DM management is Level 1 Evidence-based**
Effective self-management of T1DM requires balancing a complex array of interactive physiological parameters with algorithmic decision-making involving replacement insulin to dietary carbohydrate intake ratios. (ADA 2010) Recommended dietary intake of various food groups for adults with T1DM are prescribed in clinical guidelines for medical management developed by the National Institute of Clinical Excellence of Britain (NICE 2010), and the American Association of Clinical Endocrinologists (2010). National Australian clinical guidelines are being developed. (DoHA 2011). All guidelines recommend the incorporation of a low GI diet and consideration of GL in the management regimen. These Level 1, evidenced based recommendations indicate that a low GI diet has beneficial effects on glycaemic control in both adults and
A low Glycaemic Index (GI) diet is an effective, under-utilized tool in the management of type 1 diabetes mellitus (T1DM)

children. (Collier 1988; Fontvieille 1992; Giacco 2000; Gilbertson 2001; Thomas 2009) As well, studies demonstrate that the mean rate of any hypo-glycaemic event per month is lower in adults randomized to a low-GI diet. (Giacco 2000) Further, results from epidemiological studies show that post-prandial hyper-glycaemia is a strong independent risk factor for the development of cardiovascular disease. (Lawson 1999) As a low GI diet can significantly impact on post-prandial hyper-glycaemia, the implication for the possible reduction of premature mortality associated with T1DM due to cardiovascular disease is strong.

**Do young adults with T1DM use GI in their self-management regimens?**

There is a paucity of research worldwide that consults people with T1DM about their self-management practices. Our research aims to address this deficiency by assessing both quantitatively and qualitatively the methods of self-management that young adults with T1DM use to maintain glycaemic control. We undertook a survey of 18-35 year old Australian adults with T1DM regarding their insulin administration, insulin requirements, blood glucose testing, record keeping, target levels of control, dietary management, exercise regimens and multi-disciplinary clinician consultation. The survey was an online cross-sectional, self-reported, retrospective questionnaire regarding self-management practices. Participants were recruited from advertisements in diabetes consumer organization magazines and websites.

Of 96 respondents, 64% found GI useful in maintaining glycaemic control. However, only 56% of respondents had been educated by their diabetes healthcare team in the use of GI to assist their self-management practices. Comments from respondents indicated that many people with T1DM had personally sourced their own education on GI and incorporated use into their daily management regimens, independent of clinician input. Furthermore, only 20% of respondents considered GI or GL when assessing their insulin requirements for meals. Again respondents commented on the “woefully inadequate dietary recommendations“ as giving rise to a
A low Glycaemic Index (GI) diet is an effective, under-utilized tool in the management of type 1 diabetes mellitus (T1DM) failure to take advantage of the impact that GI has on algorithms for insulin requirements. Results also showed that only 29% of respondents had consulted a dietitian in the preceding year, even though a dietitian is considered an essential member of the recommended multi-disciplinary team care approach for management in Australia.

Conclusion
Our results indicate that a significant proportion of young adults with T1DM in Australia are not utilizing the evidenced-based, effective, and inexpensive benefits of incorporating GI into dietary considerations for self-management. Furthermore, the multi-disciplinary team care approach to treating T1DM involving consultation with a dietitian is not being accessed by the majority of patients. Such findings have implications for patient safety, improved health outcomes and improved health service delivery.

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A low Glycaemic Index (GI) diet is an effective, under-utilized tool in the management of type 1 diabetes mellitus (T1DM).


Lean body mass, breast cancer and metabolic syndrome: A role for nutrients

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Abstract
Breast cancer survivors experience sarcopenic weight gains after treatment that accelerates the onset of cardiovascular and metabolic syndrome related diseases. This review aims to provide a brief outline of: magnitude, mechanism and implications of breast cancer related sarcopenic obesity; the effect of diet and exercise interventions on LBM in this population; and to present our current intervention that is investigating independent and synergistic effects of omega-3 fatty acids (n-3FAs) and exercise on LBM in breast cancer survivors.

Introduction
For breast cancer survivors, simultaneous lean body mass (LBM) loss with fat tissue accumulation, known as sarcopenic obesity, is common (Demark-Wahnefried et al, 2001, Rooney & Wald, 2007, Harvie, 2010). Sarcopenic obesity in non-breast cancer populations is related to chronic inflammation and may increase both onset and exacerbation of multiple chronic diseases (Greenberg & Obin, 2006, Schoelson et al, 2007, Stenholm et al, 2008). As LBM has been positively associated with survival and physical function in a number of other chronic diseases, (Levine et al, 1990, Horwich & Fonarow, 2007, Sin & Man, 2007, Argiles et al, 2005, Stenholm et al, 2008) improvement of LBM quantity and quality may be an important aspect of chronic disease management, particularly in breast cancer survivors. Currently, exercise is an established intervention that attenuates LBM loss. However, dietary interventions have so far lacked specific focus of LBM maintenance in breast cancer survivor populations.
Sarcopenic obesity and breast cancer survivors

Total weight gains are reported in 50 to 96% of breast cancer survivors (Rooney & Wald, 2007, Harvie, 2010). In well populations LBM growth typically accounts for 20-40% of the total weight gained (Forbes et al, 1996), however, studies of breast cancer survivors have shown that after 1-year following chemotherapy, total fat mass gains of 2.4kg (Demark-Wahnefried et al, 2001) to 6.7kg (Harvie et al, 2004) were accompanied by LBM loss of -0.4kg to -1.7kg, respectively. Women who seemingly maintain their weight in the years after treatment still undergo these adverse changes, such that LBM loss matched increases in fat tissue (Kutynec et al, 1999).

Sarcopenic weight gain is associated with metabolic dysfunction including impaired glucose metabolism (Healy et al, 2010), high triglyceride levels (Hamilton et al, 2007) and chronic inflammation in healthy and diseased populations (Mourtzakis & Bedbrook, 2009). LBM is influences energy balance, glucose and triglyceride disposal, (Mourtzakis & Bedbrook, 2009) and has a significant effect on immune, hormonal and endocrine function in the body (Hamilton et al, 2007, Pedersen, 2009). Additionally, LBM is positively associated with survival in a number of other chronic diseases (Levine et al, 1990, Horwich & Fonarow, 2007, Stenholm et al, 2008, Argiles et al, 2005). Therefore, loss of LBM may propagate chronic disease, and should be considered as an important target for intervention in breast cancer survivors.

Mechanisms for LBM loss in breast cancer survivors

The magnitude of sarcopenic weight gains in breast cancer survivors are significantly greater than predictions using conventional energy balance calculations (Harvie et al, 2004, Demark-Wahnefried et al, 2001). The metabolic changes associated with chronic systemic inflammation, and physical inactivity may account for some of this gap between expected and actual changes (Hamilton et al, 2007). Physical inactivity is correlated with higher insulin resistance, lower triglyceride
oxidation, and higher accumulation of abdominal fat, which in turn is pro-inflammatory (Pedersen, 2009, Brandt & Pedersen, 2010, Hamilton et al, 2007). Elevated levels of inflammatory cytokines have been shown to drive net losses of LBM (Argiles et al, 2005, Stenholm et al, 2008). Therefore, regular stimulation of LBM and a dampening of systemic inflammation may be important factors when addressing body composition changes in this population (Healy et al, 2010, Emaus et al, 2010).

**Exercise and dietary interventions in breast cancer survivors**

While exercise interventions have shown to elicit improvement in LBM and physical function, dietary interventions have not targeted LBM in breast cancer survivors.

Resistance (Courneya et al, 2007, Herrero et al, 2006, Schmitz et al, 2005) and aerobic exercise training (Matthews et al, 2007, Irwin et al, 2009) have been successful in reversing or abating the adverse changes in LBM after breast cancer treatment. While absolute increases in LBM are relatively small (0 to +0.88kg), strength gains of 30% in upper and lower body, and cardiopulmonary fitness increases of ~20% are commonly reported (Schmitz et al, 2009, Kim et al, 2009, Courneya et al, 2003). Since cardiopulmonary fitness (Gau et al, 2010) and muscle strength (Newman et al, 2006) are independently associated with survival in healthy and diseased populations, changes in both quantity and function of LBM may be important outcomes in breast cancer populations.

Large RCTs in breast cancer survivor populations have assessed the effect of high fruit and vegetable intake (Saquib et al, 2008), low fat intake (Chlebowski et al, 2006) and general weight loss through energy restriction (Loprinzi et al, 1996, Jen et al, 2004, Thompson & 1152, 2010, Shaw et al, 2007), however, no dietary interventions in breast cancer survivors have primarily targeted LBM. One recent RCT noted that regardless of dietary macronutrient distribution, weight loss through energy restriction
alone resulted in losses of both LBM and fat mass (Thompson & 1152, 2010). While LBM loss is common during energy restriction in otherwise healthy overweight and obese populations (Bryner et al, 1999, Stiegler & Cunliffe, 2006, Thompson & 1152, 2010), LBM loss in this breast cancer population resulted in incidence of clinically diagnosed sarcopenia to rise from 8% pre-intervention to 18% post-intervention (Thompson & 1152, 2010). Considering the metabolic implications of LBM loss in this population, this is the first study to clearly indicate the need for additional interventions to attenuate this adverse change.

**Potential nutrients that protect LBM**

n-3FAs, through anti-inflammatory and mitochondrial influence, are associated with LBM sparing and increased fat oxidation in overweight populations (Buckley & Howe, 2009, Hill et al, 2007, Kabir et al, 2007), and attenuation of LBM loss in cancer cachexia and chronic heart failure (Mehra et al, 2006, Fearon et al, 2003, Colomer et al, 2007). In conjunction with exercise, n-3FAs supplementation have exerted more powerful effects on fat oxidation and LBM growth (Hill et al, 2007). A substantial literature supports the ability of n-3FAs to reduce inflammation through many of the pathways associated with LBM loss (Calder, 2009, Mishra et al, 2004, Babcock et al, 2003). When these findings are added to the proven benefits of n-3FAs in cardiovascular and metabolic syndrome related diseases, they have potential clinical relevance in breast cancer populations.

**A new study in breast cancer survivors using omega-3 fatty acids**

Our study to start, May 2011, will be the first to assess the effects of n-3FAs on LBM changes in breast cancer survivors. The study is a 3-armed prospective RCT that aims to recruit 135 participants who have completed treatment for breast cancer in the last year. The study will compare: n-3FAs alone, a specialised nutrition and exercise program alone, and a combination of both modalities over 6 months for their effect on LBM, inflammation and quality of life. It is hypothesised that the anti-inflammatory action of n-3FAs will
attenuate LBM loss, and that those effects will be additive to exercise and healthy eating advice.

**Conclusion**

LBM loss has been associated with poorer outcomes in a number of obesity related diseases. Interventions that target improvement of LBM may be an important component of disease management for chronic conditions, particularly in breast cancer survivors who have a predisposition to metabolic dysfunction after treatment. Our trial is hoped to give further insight into optimal management of LBM loss that is associated with chronic inflammation, and the synergy of specific nutrients and exercise in this setting.

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Cameron McDonald
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Ethnicity, adiposity and cardiovascular disease risk factors are associated with vitamin D status

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University of British Columbia

Non-Technical summary
Obesity is a risk factor for heart disease and stroke but the underlying mechanisms for which it increases risk remain to be elucidated. It is known that localized body fat accumulation determines whether an individual will be at increased risk. Body fat that accumulates in the abdomen, as opposed to fat that accumulates elsewhere, is the greatest risk indicator for heart disease and stroke. Recently, it was shown that obese individuals with poor vitamin D status were more likely to develop heart disease and stroke. Vitamin D is made by skin cells in response to sunlight, or obtained from the diet and supplements. Skin colour influences the ability of skin cells to make vitamin D in response to sunlight, with darker skin tones associated with less vitamin D. The goal of my research is to assess vitamin D status in a group of healthy European and South Asian individuals living in Vancouver and to determine the relationship of vitamin D status to obesity and risk for heart disease and stroke.

Introduction
Poor vitamin D status is prevalent in obesity (McGill et al 2008; Liel et al 1988; Wortsman et al 2000). Vitamin D, 25-hydroxyvitamin D3 (25(OH)D), is a fat-soluble vitamin that is endogenously synthesized from 7-dehydrocholesterol in skin cells following sunlight exposure (Mason 2010). Serum 25(OH)D is a biomarker for vitamin D status and poor vitamin D status is defined as a 25(OH)D concentration less than 50 nmol/L (Mason 2010).

Initially, it was thought that poor vitamin D status was due to limited outdoor activity and hence, less sun exposure. However, others suggest that adipose tissue sequesters vitamin D decreasing its bioavailability (Wortsman 2000; Parikh 2004). Other factors
that contribute to vitamin D status are age, sex, skin pigmentation, and body fat distribution (Wortsman 2000; Cheng 2010). A recent study reported that visceral adipose tissue (VAT) deposition compromises vitamin D status in an American Caucasian population (Cheng 2010). Given that increased VAT deposition is an independent risk factor for cardiovascular disease (CVD) (Gutin 2007) and that low vitamin D status is associated with CVD (Cheng 2010), poor vitamin D status may contribute to CVD associated with increased VAT deposition.

Certain population groups such as African Americans and South Asians are more susceptible to poor vitamin D status than others (Harris 2006; Knutsen 2010). Furthermore, the Multicultural-Community Health Assessment Trial (M-CHAT) showed that South Asians have greater VAT per kg of body fat than Europeans (Lear 2007). As such, the goal of this study is to investigate if serum 25(OH)D is associated with body fat distribution in European and South Asian subjects.

**Subjects and methods**

**Participant assessment**

The M-CHAT cohort is a multi-ethnic population study that includes Aboriginal, Chinese, European, and South Asian individuals residing in Vancouver, Canada. In this current study we assessed 187 Europeans and 192 South Asians. Participant assessment has been previously described (Lear 2007a, 2007b, 2009). Briefly, BMI, waist circumference, fasting plasma samples for HDL cholesterol, triglycerides, glucose and insulin were collected. Insulin resistance was estimated by homeostasis model assessment (HOMA) (Matthews 1985). VAT was quantified by CT scanner (CTi Advantage, General Electric, Milwaukee, Wisconsin) as previously described (Lear 2007a, 2007b, 2009). Total abdominal adipose tissue (TAT) was calculated from adipose tissue originating from the inside edge of the abdominal wall. Subcutaneous adipose tissue (SAT) was calculated as the difference between TAT and VAT. Total body fat was quantified by DEXA.
Serum 25(OH)D
Serum 25(OH)D was quantified by competitive chemiluminescence immunoassay (DiaSorin LIAISON® 25-OH Vitamin D TOTAL Assay). This assay was conducted by BC Biomedical Laboratories Ltd (Surrey, BC)

Vitamin D binding protein (GC) genotyping
Genomic DNA was extracted from whole blood using the QIAamp DNA Blood Minikit (Qiagen). Genotyping was accomplished using commercially available TaqMan primers and probes specific for the vitamin D binding protein rs2282679 variant (Applied Biosystems).

Statistical methods
Linear regression analysis was used to assess the association between serum 25(OH)D and clinical and metabolic parameters. Models were adjusted for age, ethnicity, sex, smoking and season of blood collection.

Results
South Asian individuals have higher VAT than European individuals ($P = 0.037$) (Table 1.).
Table 1: Study sample characteristics*

<table>
<thead>
<tr>
<th></th>
<th>European</th>
<th>South Asian</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>50.70 ± 9.14</td>
<td>44.97 ± 8.36</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Women (%)</td>
<td>49</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>27.78 ± 5.08</td>
<td>27.86 ± 4.96</td>
<td>0.882</td>
</tr>
<tr>
<td>Waist Circumference (cm)</td>
<td>89.65 ± 12.70</td>
<td>88.76 ± 12.25</td>
<td>0.492</td>
</tr>
<tr>
<td>Subcutaneous Adipose Tissue (cm²)</td>
<td>296.52 ± 140.46</td>
<td>321.68 ± 136.10</td>
<td>0.082</td>
</tr>
<tr>
<td>Visceral Adipose Tissue (cm²)</td>
<td>115.30 ± 58.51</td>
<td>127.87 ± 56.75</td>
<td>0.037</td>
</tr>
<tr>
<td>Plasma HDL-cholesterol (mmol/L)</td>
<td>1.30 ± 0.39</td>
<td>1.16 ± 0.29</td>
<td>0.000</td>
</tr>
<tr>
<td>Plasma Triglycerides (mmol/L)</td>
<td>1.47 ± 1.12</td>
<td>1.70 ± 1.06</td>
<td>0.047</td>
</tr>
<tr>
<td>Fasting Plasma Glucose (mmol/L)</td>
<td>5.22 ± 0.85</td>
<td>5.37 ± 0.73</td>
<td>0.066</td>
</tr>
<tr>
<td>Fasting Plasma Insulin (pmol/L)</td>
<td>71.19 ± 50.14</td>
<td>91.34 ± 55.55</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HOMA</td>
<td>2.51 ± 2.19</td>
<td>3.25 ± 2.34</td>
<td>0.002</td>
</tr>
<tr>
<td>Systolic Blood Pressure (mmHg)</td>
<td>119.65 ± 16.49</td>
<td>118.51 ± 14.68</td>
<td>0.481</td>
</tr>
<tr>
<td>Serum 25(OH)Vitamin D₃ (nmol/L)</td>
<td>67.42 ± 25.97</td>
<td>42.26 ± 16.59</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

* Values presented are means ± SD. Significant differences between ethnic groups assessed by ANOVA.

Increased VAT has been previously associated with increased risk for CVD, suggesting that South Asians have higher risk for
developing CVD than Europeans. This effect was accompanied by higher triglycerides ($P=0.047$), insulin ($P<0.001$), HOMA ($P=0.002$), and lower HDL-cholesterol levels ($P=0.000$) in South Asians compared to Europeans. As predicted, we saw significantly lower serum 25(OH)D in South Asians compared to Europeans ($P<0.001$) (Table 1.). Serum 25(OH)D was significantly associated with SAT, VAT, and plasma HDL-cholesterol after adjusting for ethnicity, age, sex, smoking, and season of blood collection (Table 2.).

**Table 2: Ethnicity-adjusted relations of clinical and metabolic covariates and serum 25(OH)D**

<table>
<thead>
<tr>
<th></th>
<th>Coefficient*</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td>-0.421</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age</td>
<td>0.149</td>
<td>0.005</td>
</tr>
<tr>
<td>Ln Subcutaneous Adipose Tissue</td>
<td>-0.123</td>
<td>0.024</td>
</tr>
<tr>
<td>Ln Visceral Adipose Tissue</td>
<td>-0.211</td>
<td>0.002</td>
</tr>
<tr>
<td>Plasma HDL-cholesterol</td>
<td>-0.127</td>
<td>0.025</td>
</tr>
<tr>
<td>Ln Plasma Triglycerides</td>
<td>-0.050</td>
<td>0.379</td>
</tr>
<tr>
<td>Fasting Plasma Insulin</td>
<td>0.231</td>
<td>0.163</td>
</tr>
<tr>
<td>HOMA</td>
<td>-0.307</td>
<td>0.060</td>
</tr>
</tbody>
</table>

*Coefficients represent changes in ln 25(OH) Vitamin D$_3$ for an increase in the value of the predictor variables shown. Data were assessed by linear regression analysis.

Figure 1 illustrates the association between serum 25(OH)D and VAT, as categorized by tertiles. The rs2282679 variant in the vitamin D binding protein gene ($GC$) has also been shown to influence serum 25(OH)D levels (Ahn et al 2010). As shown in Figure 2, we found that serum 25(OH)D levels were lower in subjects carrying the G allele in both Europeans and South Asians.
Discussion
Our findings indicate a relationship between body fat distribution and vitamin D status. This may contribute to the role of vitamin D.
Ethnicity, adiposity and CVD risk factors are associated with vitamin D status in CVD. Interestingly, recent findings show that ethnic-specific differences in VAT, lipid profiles and markers of glucose intolerance are associated with low vitamin D status (Cheng et al 2010; Delvin et al 2010; Freedman et al 2010). We found that South Asians have lower serum vitamin D levels than Europeans, even after adjusting for age, sex, ethnicity, BMI, ln VAT, ln SAT and season. We further showed that the poorest vitamin D status was in South Asians with the highest amount of VAT. Our findings are consistent with findings of the Framingham Study, that reported an inverse association between serum 25(OH)D and SAT and VAT (Cheng et al 2010). Other underlying factors, such as genetic variation, may contribute to differences in vitamin D status. Although we found no significant association between serum 25(OH)D levels and the GC rs2282679 variant, a trend towards lower serum 25(OH)D in individuals carrying the G allele was observed in both ethnic-groups. The association between lower serum 25(OH)D and VAT suggests that poor vitamin D status may play a role in the pathology of CVD associated with VAT and warrants further research.

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Food security in kindergartens in China

Yishi Jiang
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Introduction

Kindergartens are a crowded place, especially in the highly populated areas of China. Children are generally more vulnerable to infection than adults so kindergartens need to be places where health is protected. Food hygiene and safety is an important ingredient of a safe environment. The most frequent causes of death in children under five is pneumonia and diarrhea (World Health Statistics 2010). Diarrhea is closely linked to food hygiene and in China most kindergartens provide lunches for the children.

For some years, the Chinese government has had several laws and regulations regarding food security in place. They include Food Hygiene Law of the People's Republic of China, Hygienic Standards for Catering Services and Collective Meal Distribution Entities, Measures Concerning Supervision of Sanitation at Student Collective Meal, and Full Implementation of Graded Management for the Food Hygiene. This paper looks at the current status of food security in kindergartens.

Methods

A literature review was carried out. The words- “kindergarten” and “food security”, and “kindergarten” and “food hygiene” were used as key search words. The search was done using two databases-CNKI, and WanFang data. The inclusion criteria were the topic focusing on food security in kindergartens and that the study was done in the past five years. The main findings are summarised below.
Results and discussions

Food hygiene licences
Almost every paper reviewed mentioned and analyzed this factor but the results varied enormously. Generally the proportion of kindergartens that had licences was higher in public facilities than in private ones. The percentage of kindergartens in urban areas with a licence ranged from 14.8% (Yang J et al 2009) to 100% (Zhang YF 2006). In one study the proportion of private kindergartens with a licence dipped as low as 5.8%. This result is very worrying and could mean that food inspections are not normative for kindergartens. So the health inspection and supervision departments should take the responsibility to enhance the food security inspections in kindergartens and emphasis on the strict admittance for kindergarten canteens.

Health certificates for canteen staff
The proportion of kindergarten canteen staff with health certificates ranged from 20.0% (Wu ST et al 2006) to 98.9% (Zhang YF 2006) in urban areas. This was higher than that in rural kindergartens. The health knowledge awareness in canteen staff did not exceed 60%, illustrating that the staff lacked the necessary qualification for food preparation. This suggests that the recruitment of kindergarten canteens should include a test and a verification of their current health certificates. To support this Health Inspection and Supervision checks should incorporate checks on staff qualifications. Additionally canteen staff need a continuing education programme.

Food preparation facilities
Only a few studies (Zhang YF 2006, Zhang SY et al 2010) looked at facilities for food preparation. They showed the proportion for infrastructures meeting health standards has achieved 90% or above, but also that many facilities still have a lot of problems despite the overall progress. The problems include a lack of sinks leading to different kinds of food being prepared in the same area; lack of methods to prevent infestation and too small a size kitchen compared to the dining area being served. A way to address this
could be more emphasis on the structure of food preparation facilities when planning permission is requested and for inspectors to force the re-design or renovation of facilities which do not comply with the health standards.

**Food preparation**

In China, food preparation inspection checks the cleaning and disinfection of utensils, food storage, and food processing. The majority of studies in the literature review showed 50-70% of facilities met the health standard for utensil hygiene with only four studies giving a rate of in excess of 80% (Liang HF et al 2006, Wang XX 2006, Zhang ZY 2010, Hou CY 2011). One study reported a rate of 100.0% (Wang XX 2006) for public kindergartens. Utensil cleaning and disinfection is one of the most important procedures in food processing and recently with the enhancement of health inspection it has been improved. However there is still room for more improvement especially in the private, the small-scale and rural kindergartens.

The number of kindergartens awarded certificates for quality of raw food was as low as 0% in one study (Xu WP et al 2007) and only as high as 33.3% in another (Wang XX 2006). This indicates that rules and legislature are not been well enforced in this area. Problems with raw foods can lead to diarrhoea and a range of other serious illnesses. The health inspection practices round this area need to be strengthened and enforced.

**Management Structure and systems**

The studies mainly looked at the management system and the management staff. The literature review showed that only half of the kindergartens had established a food security management system. In these, only 21.7% (Yan J et al 2006), to 33.3% (Xia ZW 2007) had the headmaster taking the lead responsibility. This rate was nearly as low as those facilities which employed food security management staff. We can deduce that most kindergartens have not established a food security management system with professional staff. The studies suggested that the way
forward was for education and health inspection departments to work together to train kindergarten staff and set up such systems.

**Conclusion**
The food security in kindergartens is very important to child health, and it has an impact on not just one child, but very large number of children. Emphasis therefore should be put on the health management and inspection for kindergartens. The literature review has shown there are problems which can be addressed by improved routine health inspection of these facilities. The key responsible agencies could play a significant role provided they themselves are strong and they work together in a cooperative manner.

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Food security in kindergartens in China


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The feasibility of incorporating micronutrient information into English Language teaching materials for use in African schools

Hilary Brook
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The aim of this project is to improve young people’s understanding of the significance of micronutrients in establishing and maintaining health by designing lessons which will enable them to make informed decisions as adult producers and consumers of foods.

The project takes as its starting point the World Bank report ‘Repositioning nutrition as central to development’. The Bank highlights micronutrient deficiencies in iodine (the leading cause of preventable brain damage) affecting 35% of the world’s population, iron (causing anaemia) affecting 40% and Vitamin A (causing blindness and reducing resistance to infections) affecting more than 40%. (The World Bank 2006 p.7) Access to food is often not the key issue (Bank p.60) and deficiencies are impossible to detect without clinical tests so that ‘Families do not know there is a nutrition problem until it is too late.’ (Bank 2006, p.32). 42% of Tanzanian under-fives are classified as stunted (http://www.unicef.org/pon00/leaguetos/.htm) – a low height-for-age condition which indicates cumulative effects of under-nutrition and infection since birth, and even before. Malnutrition is an underlying cause in 50% of the 91 per 1,000 under-five deaths. (WHO 2009 p. 3-4)

The Tanzanian diet

Traditional diet is based on cereals, maize or tubers, boiled in water to form a thick porridge, and usually served with a “relish” of meat or fish (prosperous households only), oil, groundnuts, cultivated or gathered leaves or insects. The diet is low in micronutrients.
Consumption of micronutrient-rich vegetables is often low, particularly in lower income groups: 154g per head per day in the
lowest quintile and 317g in the highest quintile, compared with a World Health Organisation recommendation of 400g of fruit and vegetables per head per day (Shackleton, Pasquini & Drescher 2009, p.110).

A second study found that 33% of participants in a humid district had consumed no vegetables at all the previous day. (Shackleton et al 2009, p.111).

**Food production**

Tanzania is characterised by poor soils, seasonal, sometimes irregular, rainfall and periodic famine as a result of shifts in the Intertropical Convergence Zone. These have contributed to this physically large country’s relatively low population. (40 million) (Iliffe 1979, p.13).

Two wet seasons – short (November – December) and long – (mid March – May) exacerbate cultivation problems. Climate change is expected to increase rainfall, but could also increase flooding (Conway 2009, p.8).

Distinct growing seasons are blamed for increasing the popularity of maize, the first crop to appear following new rains. In the words of food specialist James McCann ‘By the first decade of the twenty first century a tidal wave of maize had engulfed Africa’. (McCann 2005, p.7) African maize, which is usually white, is low in Vitamin A. It lacks Vitamin B and contains leucine which blocks absorption of niacin, leading to protein deficiency. Its iron is difficult to absorb.

It is intended that this project will help to focus attention on recent work to publicise nutritional and agricultural strengths of traditional African crops. These include the findings of the Indigeno Veg network, which has identified 7,000 indigenous vegetables (Shackleton et al 2009, p.xxi), the Ibadan-based Collaborative Study of Cassava in Africa and the work Lost Crops of Africa which sets out the advantages of sorghum and millet.
Additionally, lessons will seek to explain the significance of fortified foodstuffs. Tanzania currently has one fortification programme, addition of iodine to salt.

**The school system**

Primary education starts at age seven and can continue for seven years, catering for an estimated 8.4 million pupils. (UNESCO Global Education Database). A small number of students continue to secondary education. The country’s high birthrate - 3.1% - has left the system struggling.

English Language teaching is allocated a generous seven periods a week. By the end of their seventh year pupils are expected to read/listen to a text and to answer questions on it.

National English Language co-ordinator Stomin Msaka says that he would like to see all pupils – including the large number who will seldom use English in later life – take away something of value from this investment. ‘When I was teaching myself I has students who wanted to know why they were obliged to spend so long on the language,’ he says.

‘Nutrition education is an interesting idea, which could also help with our shortage of teaching materials.’ (personal interview 27 Oct. 2010).

Home economics co-ordinator Zena Amiri, currently working on a revised syllabus, says: ‘Nutrition is not timetabled as a separate subject, but in this society it is increasingly important that consumers are able to make informed decisions, particularly about food. It’s the information, not the lesson title that matters.’ (personal interview 27 Oct. 2010).

**Project delivery**

The researcher is working with groups of teachers at grassroots level. After briefing, teachers work together on lesson modules, which combine micronutrient information with English syllabus
requirements. Each module is expected to last a class several weeks, combining short stories constructed round a single micronutrient theme with vocabulary, translation and grammar work, fact sheets, games and puzzles.

A separate teachers’ handbook will contain more detailed nutrition information, as well as suggestions for practical activities, competitions, surveys, art work and role play. Modules will be submitted to the curriculum authority before printing, so that suggestions can be incorporated. At the end of each module teachers and pupils will be invited to offer feedback.

It is anticipated that a 24-page A5 module (six folded A4 sheets) will cost around Tz250/- (about US$0.20) to produce. It will become the property of the pupil. To meet the needs of less able pupils, micronutrient information will appear in Kiswahili.

References


Hilary Brook
The feasibility of incorporating micronutrient information into English Language teaching materials for use in African schools


Childhood obesity and overweight in China: beyond a changing diet

Shiyun Hu
Fudan University

Background
Since the start of social reform and rapid economic development, the Chinese have entered a stage of nutrition transition (Du et al 2002). This transition has increased the prevalence of non communicable health risk factors such as obesity in all parts of China, except for the poorer western rural areas (Ji et al 2008).

The 2006 Third National Childhood Obesity Survey showed that the rate of obesity among 0-6 year old children in China is 7.2% (Wang et al 2008). In 1986 the figure was only 0.9% and in 1996, 2% (Shan et al 2004). Between 1985 and 2005, the combined prevalence of obesity and overweight for 7-18 year-old Chinese youth increased from 1.6% and 1.8% to 32.5% and 17.6% (Ji 2007), for males and females, respectively, in the coastal big city populations. These figures suggest that the obesity prevalence in some urban Chinese populations has approached that of developed countries (Ji et al 2008).

Prevention of childhood obesity in young people is universally viewed as the best approach to reverse global prevalence of adult obesity (Han et al 2010). Before any prevention strategies and intervention can be developed, the pattern and determinant factors of the epidemic need to be clearly understood.

Objectives and methods
The objectives of this study are to describe the patterns and chief determinant factors which underpin childhood obesity in China. The methodology used is a literature review.

Papers were reviewed from China National Knowledge Infrastructure (in Chinese) and Web-of-Knowledge (in English). A
range of key search words were used in various combinations. Examples of the key words were:- child, children, childhood, boy(s), girl(s); obesity, overweight, fat; China, Chinese; prevalence, epidemiology, epidemiological, influencing, determinant factors. The inclusion criteria were the papers had to be relevant to the topic and published within the last 5 years.

**Results and discussions**
The nutrition transition in China which has occurred over the past three decades has been characterised by a decrease in undernutrition and an increase in overweight and obesity. Peoples’ diet has changed to one which is high in fat and energy content and low in fibre. The average consumption of all animal foods (except milk) has increased while cereal intake has decreased (Zhai et al 2009).

For childhood overweight and obesity the following patterns can be seen. 1. The prevalence among sub-population gradually increases from eastern-coast area to western-inland area. The change is more obvious in urban than in rural areas. 2. The epidemic among children under 7 years is significantly higher than that among adolescents. 3. The prevalence in girls is much lower than in boys which are opposite to the trends in western countries. 4. Most obese and overweight children are from families with better economic situation and higher parent education level. (Ji 2008)

Changes in income, daily diet and physical activity levels have been a key contributing factor in childhood weight increase (Ji et al 2008). In the past, in underdeveloped areas, the most available and affordable diets used to be natural food sources that are high in fibre and low in fat such as grains, fruits and vegetables. Today processed foods and drinks which are high in fat, salt and sugar account for the majority of the diet (Drewnowski et al 1997). Unhealthy diet is a key modifiable risk factor for obesity and overweight.
The excessive growth of body weight at early stage of life increases the risk of adult obesity (Ji 2010). Beside the changing diet, traditional perception and beliefs of health have also played a part and led to overfeeding practices. In China, the term 虎头虎脑 (hǔ tóu hǔ nǎo) is often used to describe a healthy and lively baby, especially for boys. The term suggests that chubbiness equals health. Many parents and grandparents still have this in mind and they lack awareness about the harm of childhood obesity and overweight.

In addition the changing pattern of child care is another important factor for this problem. The one child policy in China has led to a very common family structure of 4-grandparents, 2-parents and 1-grandkid (Cheng 2005). The size of families has become smaller and young couples tend to live by themselves. However within three-generation families grandparents still often act as primary caregivers. They will provide care before and after delivery and continue this care responsibility for several years until the young couple can handle the situation by themselves. The grandparents take the responsibility to do the housework and organise the food. They base their child feeding practices on their own childhood experiences and many experienced periods of starvation (Jiang et al 2006). The grandparents also use food as punishment or reward for children.

Another unique pattern of childhood obesity and overweight in China is the higher prevalence of obesity in boys to girls. The difference becomes bigger as they get older. The explanation given in research papers is that fat boys are a symbol of health and that caregivers place a higher value on boys so over feed them (He 2010).

Finally, the popularity of television and the computer has led to a generation of children who are much less physically active so increasing their risk of obesity.
Conclusion
China appears to be at the beginning of an epidemic of child obesity and overweight. The causes of childhood obesity are the same as those which have led to the rapid increase in adult obesity which are a change in nutritional and lifestyle practices. Modern social practices couple with traditional Chinese beliefs and practices to give us a rise in childhood obesity for which we need to develop effective interventions.

References


Is food education making pupils educationally obese?

Fran Ryland
University of Birmingham

Introduction
In England today there is a ‘childhood obesity crisis’ (Campbell 2010) and, in addition, anorexia cases requiring hospital treatment have risen 80% in the last 10 years (Anorexic 2009). Educators have long regarded food as a key topic in science education and therefore included it in the National Curriculum (DfEE and QCA 1999). One might assume that a good understanding of food could help reduce the number of people following an unhealthy lifestyle. However, the figures of people living an unhealthy lifestyle appear to be growing. So what is going wrong?

My research focused on pupils aged 6 to 14 from a primary and a secondary school and explored their experiences of learning about food in the context of the science curriculum. The study included documentary analysis of the food section of the National Curriculum, schemes of work and pupils’ classwork, and consulted pupils and teachers directly.

Documentary analysis
The National Curriculum in England is based on the spiral curriculum (Bruner 1960) meaning topics are introduced to pupils early in their education and are revisited at intervals. During each revisit the curriculum gradually builds in detail (known as progression). Food, as a key topic, is revisited in the National Curriculum during each key stage (KS) amounting to four occasions (KS1, age 5-7; KS2, age 7-11; KS3, age 11-14; and KS4, age 13-16). Schools interpret the National Curriculum into schemes of work and lesson plans.

The food section of the National Curriculum was subjected to documentary analysis and was found to show clear progression
across the key stages. The study then analysed schemes of work including those produced by the QCA (a UK government agency) and the schools involved in the study. Schemes of work detail the aims of the lessons and what concepts should be taught. The data indicated that, within the schemes of work analysed, food was revisited twice per KS during KS1, KS2 and KS3 and once in KS4. When the schemes were analysed for progression the data indicated that there was little progression during the first and second revisit in KS1 and KS2 and some progression was observed during KS3. When pupils’ classwork was analysed it was found that concepts included in the National Curriculum for KS3 were being introduced as early as KS1. For example, the concept of a balanced diet was introduced in year 2 (age 6) and then repeatedly revisited in years 3 (age 7), 5 (age 9), 8 (age 12) and 9 (age 13).

Pupil Consultation
The pupils were consulted using questionnaires and focus groups. The majority of pupils consulted felt learning about food was important due to the potential health benefits. However, enjoyment of learning about food dropped with increasing age and by age 13-14 only 25% of pupils expressed positive views about the topic. When asked to qualify their views pupils highlighted repetition of teaching concepts as a major concern. They also stated that food is taught in other school subjects such as personal, social and health education and design technology: food. Commenting on food education pupils stated: ‘you hear about it all the time and it gets annoying rather than interesting’ (age 12) and ‘it’s getting boring as we do it loads in other lessons and learn the same stuff over and over’ (age 13).

Pupils also stated that they learnt about food outside of school from many sources including family, television and the internet. The types of information gained outside school included healthy and unhealthy foods and a balanced diet.
Teacher consultation

Teachers from KS2 and KS3 were interviewed in the study. They were largely unaware what pupils had learnt about food in the earlier KS despite claiming that they assessed pupils’ prior knowledge. For example, a KS2 teacher stated he had ‘no idea’ what was taught in KS1. As teachers were unclear what pupils had covered before they unknowingly included concepts that were repetitious for the pupils.

Teachers also described problems within their own KS. They explained how the schemes of work required the topic to be taught twice per KS and they then felt that if they covered content according the scheme of work, repetition or poor progression may occur. For example, in KS2 food is taught in year 3 and again in year 5. Year 5 teachers, aware that repetition may occur, decided to include concepts from the next KS so that they could cover ‘new’ material. They did this with the knowledge that this may create further problems of repetition later:

‘we are aware that we cover some material from secondary school ... we like to extend the children...[I am aware] they then get bored in year 7 and 8’

(Year 5 teacher)

These actions further compounded the problem of repetition as KS3 teachers were unaware that the concepts had been covered before.

Discussion

Data collected for the study illustrated that although the National Curriculum outlined what pupils should cover in each KS and this demonstrated progression of knowledge, by the time it was translated into schemes of work errors of interpretation appeared. This meant that concepts were introduced too early and then repetitively revisited throughout the pupils’ education. This
situation was compounded by teachers choosing to introduce concepts early and by not assessing pupils’ current knowledge adequately. Further, food is covered in a number or school subjects which adds to the repetition pupils’ experience. By the time pupils reach secondary school (KS3) they become increasingly disengaged with the topic.

Pupils are taught about food so much that they are becoming educationally obese: weighed down by excessive and unnecessary teaching of concepts. It is simply unnecessary to teach the same concepts in three school subjects and to revisit them so frequently. What is unclear from the study is the deeper psychological impact on the pupils: Is this disengagement causing the pupils to switch off and ignore the healthy eating message? Are vulnerable pupils taking the healthy message too strongly and eliminating food groups altogether? The study recommends clear identification of when concepts should be taught and in which school subject, along with less frequent revisiting supported by assessment of pupils’ prior knowledge by teachers.

References


The linkage between phage life cycle and staphylococcal enterotoxin A (SEA) expression

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Introduction

*Staphylococcus aureus* is a major human pathogen causing a wild range of diseases, from food poisoning to severe life-threatening conditions. *S. aureus* is normally found on the skin of warm-blooded animals, and frequently associated with food contamination. Staphylococcal food poisoning (SFP) is the third most common causative agent in food-borne illness in the world. Enterotoxins produced by *Staphylococcus aureus* are the causative agents of SFP. To date, 21 different enterotoxins or enterotoxin-like proteins are found and characterised in their structures and biological activities. Among them, staphylococcal enterotoxin A (SEA) is the most common enterotoxin found in SFP outbreaks. SEA is formed during the bacterial growth and accumulates in pure liquid cultures of planktonic *S. aureus*. Based on the specific levels of SEA produced, strains have a variation from 0,05 ng SEA/ml/OD₆₂₀ to 658 ng SEA/ml/OD₆₂₀. The SEA gene (*sea*) is carried by a group of related temperate bacteriophages. The phage inserted into the bacterial chromosome as a prophage behaves like a part of the bacterial genome. However under environmental stress conditions such as mild food preservation conditions, the prophage can be induced to replicate the phage genome and release new bacteriophages (Wallin-Carlquist et al 2010). The released phages can infect new bacteria and repeat the life cycle of the temperate phage. The *sea* expression is partially regulated by the prophage (Sumby et al 2003; Wallin-Carlquist et al 2010), which is different from many other enterotoxin genes such as SEB,
The linkage between phage life cycle and staphylococcal enterotoxin A (SEA) expression

SEC and SED. Sequence analysis of the sea gene and its neighbouring genomic regions indicates that one can group SEA-producing strains into two major groups, SEA1 and SEA2 (Wallin-Carlquist et al 2010). Borst et al (1994) have showed that the promoter region, P1, immediately upstream sea is conserved and present in both groups. There is also a second promoter, P2, proved to express sea after prophage induction according to Sumby et al (2003). In this paper, we have found that S. aureus strains producing high amounts of SEA belong to the SEA1 group and strains producing low amounts of SEA belong to the SEA2 group. Furthermore, the SEA1 strains were also found to be connected with a stress-induced boost of SEA production as the second promoter, P2, was activated.

Results and discussion
In the present study, we have used the antitumor antibiotic mitomycin C (MC) as a prophage-inducing agent which was added in the middle of the exponential growth phase of S. aureus. Twenty one S. aureus strains harbouring sea were investigated in order to monitor the specific levels of sea mRNA (sea transcriptions) and specific extracellular SEA levels. Furthermore, two reference strains representing SEA1 and SEA2 were studied further to determine phage numbers, i.e. plaque forming units (PFU). Real-time PCR was used to quantify the expression level of sea as long transcripts (initiated from the P2 promoter) and short transcripts (P1 and P2 transcripts). By this way, we were able to see the effect of the phage-associated promoter, P2, on sea expression and SEA production levels. Based on our preliminary data, the SEA1 reference strain was at least one log unit higher in PFU than the SEA2 reference strain. Both strains were sensitive to prophage induction by MC. PFU was increased by at least three log units comparing with control culture with no MC after three hours treatment. Under identical growth conditions, the total sea gene expression level differed much between the 21 strains tested. For most SEA1 strains, the total sea expression level increased about 10 to 100 times after MC treatment, mainly due to the activation of P2 and increased levels of long sea transcript. Furthermore, a
correlation with PFU was observed. It was also proved by the specific SEA production levels that all strains with P₂ activation increased after MC treatment comparing to control cultures. This increase could be up to 10 fold. Our findings may suggest that any stress factors affecting the prophage such as low pH, low temperature, weak acids, may boost SEA production in most SEA₁ strains, which are all high SEA producing strains. Furthermore, all SEA₂ strains lacked the long P₂ transcripts and produced small amounts of SEA, which was the reason why MC treatment slightly increased PFU, but had no significant effect on sea expression. Thus, most SEA₂ strains are most likely harmless due to their very low production level of SEA. This brings challenges to our current food industry, on the means of achieving food safety by using mild preservation. The finding that preservatives used to control S. aureus in foods may actually stimulate SEA expression sheds new light on, and brings question into, traditional food preservation techniques. In conclusion, in order to improve the production of microbiologically safe food that also has a high quality for human consumption, data on food-borne microbial virulence are required to complement existing knowledge on the growth and survival ability of pathogenic microbes. Further investigations are urgently required to identify factors such as food composition, gas atmosphere, preservatives, temperature, etc., that are responsible for down- and up-regulating virulence expression in pathogens.

References


Encapsulation of amino acids and peptides to target their delivery in the digestive system

Graham O’Neill
University College of Dublin

Introduction
As the world’s population continues to increase so do food related diseases such as obesity and starvation. According to the WHO, 65% of the world’s population live in countries where overweight and obesity kills more people than being underweight (WHO., 2011). Disturbingly, in 2010 almost 43 million children under the age of five were overweight (Blössner & de Onis 2005). The main health consequences associated with overweight and obesity include cardiovascular diseases, diabetes, musculoskeletal disorders and some cancers (Blössner & de Onis 2005, WHO, 2011).

Bioactive milk peptides have a wide array of benefits on human health including effects on the cardiovascular and immune system, anticarcinogenic (Madureira et al, 2007) mineral binding and satiety inducing properties (Haque et al, 2009). Therefore, bioactive milk peptides may help reduce the incidents of chronic disease, which account for so many deaths. However, for these bioactive peptides to exert their health benefits they have to be delivered to the site of absorption.

The human digestive system is designed to break down proteins and peptides into their constituent amino acids. The repercussions of this are, that bioactive peptides will be broken down, resulting in a loss of their physiological activity. The aim of this study is to encapsulate milk bioactive peptides to allow their targeted delivery and incorporation into foods. A significant number of bioactive milk peptides are hydrophobic. Therefore this study focused on creating an encapsulation system to protect and target the delivery of model milk hydrolysate bioactives.
Encapsulation of amino acids and peptides to target their delivery in the digestive system

Materials and methods

Materials
Whey Protein Isolate (WPI) was obtained from Davisco Food Ingredients Int. (Le Sueur, Minn., U.S.A.). Calcium chloride dihydrate was purchased from E.Merck (Damstadt, F.R. Germany). Disodium phosphate anhydrous was obtained from BDH chemicals Ltd (Poole England). Methanol, tryptophan and phenylalanine were purchased from Sigma Aldrich (St. Louis, MO, USA). The peptides were purchased from Bachem (Switzerland).

Preparation of whey protein beads
WPI was rehydrated in water to make a 10% w/w solution and heat denatured at 80°C. To produce microgel beads the WPI solutions was dropped into a calcium chloride bath (100mM) using a peristaltic pump.

Amino acid and peptide absorption test
Solutions of amino acids and peptides were made up to 0.2 g/L. The whey protein gel beads (20) were placed in test tubes containing 1, 1.5, 2, 3, 5, 10, 15 mL of amino acid or peptide solution. After 24 hours the solutions were analysed on the RP-HPLC to determine the concentration of amino acids and peptides. The percent encapsulation was calculated from the decrease in amino acid and peptide concentration in the solution.

Quantification of amino acids and peptides by HPLC
The amino acid and peptide solutions (10µl) were injected directly onto the HPLC column. HPLC separation was conducted on an Agilent 1200 HPLC system (Agilent Technologies, Santa Clara, CA) using an Agilent Eclipse XDB-C_{18} (150 mm × 4.6 mm i.d.; 5 µm particle size) column with a C_{18} guard column (Phenomenex, Macclesfield, UK). The mobile phase was 0.025M phosphate buffer and methanol at a flow rate of 1mL min^{-1}. UV detection was conducted at 210 nm.
Percentage encapsulation
The percentage encapsulation was calculated by measuring the quantity of amino acid or peptide in solution before and after incubation with the whey protein beads. Percentage encapsulation was calculated as follows:

\[
\text{Encapsulation} = \frac{\text{Quantity of peptide in the bead (mg)}}{\text{Quantity of Peptide in original solution (mg)}} \times 100
\]

Volume bead/Volume of external solution
The volume of bead (ml) over the volume of external solution (ml) is used as the unit on the X axis in figures 2, 3. This is used to allow for the change in the bead to solution ratio of each sample as bead volume was constant.

Results and discussion
Hydrophobicity
The hydrophobicity of the amino acid phenylalanine, dipeptide (phenylalanine-tryptophan) and pentapeptide (Leucine-tryptophan-methionine-arginine-phenylalanine) was measured using RP-HPLC. As expected retention time increased with the number of hydrophobic amino acids present (figure 1).

![Figure 1: Chromatogram showing retention times of the phenylalanine, dipeptide and pentapeptide](image-url)
Encapsulation level

The % encapsulation for each of the amino acids and peptides is shown in Figure 2. Interestingly, as hydrophobicity increased the % encapsulation also increased.

The higher levels of encapsulation were found at bead/external solution ratios of 0.2. At a fixed volume of beads (20 beads) the percentage encapsulation decreased with increasing volume of solution. Basically, as solution volume increased the concentration remained constant (0.2g/L) but the amount of amino acid/peptide in solution increased greatly relative to the size of the bead.

![Figure 2: Percentage encapsulation of phenylalanine, tryptophan, dipeptide and pentapeptide in WPI hydrogel bead.](image)
bead increasing to 0.8g/L. At a bead/external solution ratio of 0.01 the % encapsulation is lower at 19% but the concentration in the bead has increased significantly to 2.8g/L.

![Concentration of pentapeptide within the WPI bead in relation to encapsulation percentage](image)

**Figure 3: Concentration of pentapeptide within the WPI bead in relation to encapsulation percentage**

**Conclusion**

Whey protein beads can successfully encapsulate peptides at high concentrations of peptides. This will facilitate the incorporation of bioactives into foods and targeted delivery to their physiological sites of action. The highly hydrophobic nature of milk peptides will suit this cost effective encapsulation model. Overall this system shows great potential for protecting bioactives and ensuring their delivery within the body to effect health benefits.

**References**

Graham O’Neill
Encapsulation of amino acids and peptides to target their delivery in the digestive system


Back extrusion and modified texture profile analysis (TPA) for testing the texture of biscuit boluses at the point of swallow

Ashley Young
University of Auckland

Introduction

The four factors of food quality are nutrition, appearance, flavour and texture (Bourne, 2002). Regardless of a food’s nutritional benefits, the consumer must find the other factors of food quality acceptable before they will eat it. An increasing body of work designs foods for human health applications with this fact in mind. For example, thickened liquids for the intervention of dysphagia (swallowing problems) (Robbins & Hind, 2008, Nishinari, 2009), and structures to reduce salt and sugar levels in food without compromising taste (Mosca et al, 2010, Noort et al, 2010).


The “Food Structure Platform” is a multi-disciplinary programme in New Zealand conducting fundamental research on the influence of
structure on the textural attributes of solid foods and the change of texture during mastication. An understanding of which, will enable the manipulation of food texture for human health and acceptability applications. A biscuit-based model food has been developed by the programme team. A modified texture profile analysis (TPA) (Friedman et al, 1963, Breene, 1975, Bourne, 2002, Chen, 2009) and back extrusion (Steffe & Osorio, 1987, Osorio & Steffe, 1991, Steffe, 1996, Gujral & Sodhi, 2002) have been selected to instrumentally quantify “texture”. The tests will measure the mechanical and rheological properties of the bolus at numerous points during the mastication process. They enable testing using a relatively simple geometry, even when the particle size is quite large (Steffe & Osorio, 1987, Osorio & Steffe, 1991, Steffe, 1996, Gujral & Sodhi, 2002).

The objective of the work presented in this paper is to develop methodology for back extrusion and modified TPA tests to quantify the texture of biscuit boluses at the point of swallow.

Materials and methods
Biscuit formulation and initial properties
The biscuits developed by the Food Structure Platform team have varying fat:sugar:starch content along an axis between biscuits with extremes of texture (shortbread and ginger nut). Five biscuit types were produced; an increase in the sugar/fat ratio resulted in an increase in the perceived sensory “hardness” and 3-point bend test fracture stress (Table 1) (Kim, 2011).

Bolus collection
One chewing subject was used for the investigation. The subject took a natural bite, masticated until they first felt the urge to swallow then expectorated into a sealed container. Prior to testing the mass of biscuit in bite, mastication period and bolus mass were recorded.
Table 1: Mean fracture stress and standard deviation of biscuit recipes SP1-SP5 (increasing sugar/fat ratio and sensory hardness)

<table>
<thead>
<tr>
<th>Biscuit recipe</th>
<th>Sugar/fat ratio</th>
<th>Fracture stress ± 1 SD (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP1</td>
<td>0.71</td>
<td>490±40</td>
</tr>
<tr>
<td>SP2</td>
<td>1.1</td>
<td>570±90</td>
</tr>
<tr>
<td>SP3</td>
<td>1.47</td>
<td>880±160</td>
</tr>
<tr>
<td>SP4</td>
<td>1.87</td>
<td>1240±110</td>
</tr>
<tr>
<td>SP5</td>
<td>2.24</td>
<td>1300±170</td>
</tr>
</tbody>
</table>

Mechanical testing
For both modified TPA and back extrusion, 5 replicates of each of the 5 biscuit types were tested at ambient conditions. A 17.6mm diameter stainless steel piston was attached to the moving crosshead of an Instron 5543 (fitted with 1000N load cell). The bolus was transferred to the perspex cup (internal diameter of 22mm and height of 60mm), the bolus surface levelled and the cup secured to the base adaptor of the Instron. The piston was brought into contact with the bolus surface (a preload of 0.1N ensured contact).

Back extrusion
The piston was thrust to 80% of the height of the bolus, followed by a two minute hold. Testing was carried out at two speeds (200mm.min⁻¹ and 1000mm.min⁻¹) to determine n and η using the methods described for power law fluids (Equation 1) (Steffe & Osorio, 1987).

\[ \tau = \eta \dot{\gamma}^n \]  
(Equation 1)

\[ \tau = \text{shear stress (Pa).} \]
\[ \dot{\gamma} = \text{shear rate (s}^{-1}). \]
\[ \eta = \text{consistency coefficient (Pa.s}^n). \]
\[ n = \text{flow behaviour index (dimensionless).} \]
Ashley Young
Back extrusion and modified texture profile analysis (TPA) for testing the texture of biscuit boluses at the point of swallow

\( \eta \) is a measure of the fluid's resistance to flow and \( n \) describes the flow behaviour of the fluid. For example, if a material is stirred quickly, will its resistance to flow be: 1) greater than \( 1 < n < \infty \) (shear thickening); 2) equal to \( n = 1 \) (Newtonian); or 3) less than \( 0 < n < 1 \) (shear thinning) if it was stirred slowly.

**Modified TPA**
TPA links the mechanical properties of a food and its texture profile (Friedman et al, 1963, Breene, 1975, Bourne, 2002, Chen, 2009). Testing consisted of two consecutive piston thrusts (100mm.min\(^{-1}\)) to 80% of the original height of the bolus. These tests differ from traditional TPA as a cup and piston were used as opposed to platen. Figure 1 shows how the TPA parameters were calculated.

![Figure 1: Example of the output and calculated parameters of a modified TPA test](image)

**Results/discussion**
**Back extrusion**
Saliva is a shear thinning fluid (Bongaerts et al, 2007); hence a bolus (a biscuit particle and saliva suspension) is also expected to be shear thinning. Table 2 summarises the flow behaviour index
(n) values obtained from back extrusion tests. The n value for all biscuit types is less than one, indicating that the boluses exhibit shear thinning behaviour. Table 2: Flow behaviour index (n) obtained from back extrusion tests on biscuit boluses at the point of swallow

Table 2: Flow behaviour index (n) obtained from back extrusion tests on biscuit boluses at the point of swallow

<table>
<thead>
<tr>
<th>Biscuit recipe</th>
<th>Sugar/fat ratio</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP1</td>
<td>0.71</td>
<td>0.46</td>
</tr>
<tr>
<td>SP2</td>
<td>1.1</td>
<td>0.41</td>
</tr>
<tr>
<td>SP3</td>
<td>1.47</td>
<td>0.50</td>
</tr>
<tr>
<td>SP4</td>
<td>1.87</td>
<td>0.38</td>
</tr>
<tr>
<td>SP5</td>
<td>2.24</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Figure 2: Mean consistency coefficient (η) (± 1 SD) obtained from back extrusion tests on biscuit boluses at the point of swallow

Figure 2 shows that the consistency coefficient, η, exhibited a decreasing trend with increasing sugar/fat ratio. This indicates that the sugar/fat ratio influences the resistance to flow of the bolus (at the point of swallow). η has previously been linked to swallowing behaviour (Germain et al, 2006) and is important in the design of
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Back extrusion and modified texture profile analysis (TPA) for testing the texture of biscuit boluses at the point of swallow

foods for the intervention of dysphagia (Robbins & Hind, 2008, Nishinari, 2009).

Modified TPA
It is expected that hardness and adhesiveness are affected by the bolus’ resistance to flow. As seen in Figure 3, both parameters decreased with increasing sugar/fat ratio. The trend was also evident in the \( \eta \) values obtained using back extrusion. This indicates a possible link between bolus “texture” determined using modified TPA and back extrusion; imitative and fundamental objective texture measurement techniques, respectively.

Cohesiveness appears to be unaffected by the starting properties of the biscuit (\( p>0.16 \)). This implies that irrespective of the starting texture of the food material, the bolus needs to achieve a certain cohesiveness before swallowing is initiated; this is in agreement with other reported results (Nagatomi et al, 2008) and the peak cohesive force optimum swallow model (Prinz & Lucas, 1997).

Figure 3: Mean hardness, adhesiveness and cohesiveness values (± 1 SD) obtained from modified TPA tests on biscuit boluses at the point of swallow
Conclusions
Back extrusion and modified TPA protocol were used to quantify the texture of 5 biscuit-based boluses at the point of swallow. Back extrusion protocol characterised the boluses as shear thinning ($n$ ranged from 0.38 to 0.50). With increasing sugar/fat ratio (and increasing fracture stress), the consistency coefficient decreased. This trend was also exhibited by hardness and adhesiveness obtained using a modified TPA protocol. Cohesiveness was unaffected by the biscuit composition and fracture stress, indicating a certain cohesiveness must be reached to initiate swallowing. Results presented in this paper contribute to an understanding of how the properties of solid foods are changed by mastication; the overall goal being the manipulation of food texture for human health and acceptability applications.

Acknowledgements
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The effect of a boss in a team on cooperation

Ilon Yu
University of Amsterdam

Introduction

People working together are able to achieve more than people working separately. Cooperation is crucial for productivity and seems to be inevitable in this complex society. Although cooperation itself is great, in practice it does not work out easily. There is an inherent problem when people have to work together, the problem of free-riding. This phenomenon of free-riding occurs in formal spheres, for instance, if construction companies need to work together on a big project. It is also present in informal spheres, such as household duties that need to be carried out by several people who are living together. Environmental issues such as investing in sustainable resources in which hardly anyone feels the urge to do, though people know it is better for the environment in the long term, is another example of a free-riding problem. These environmental issues can also be translated to food issues such as global food security. To improve global food security a setting to facilitate cooperation may be desirable. On the one hand, there are parties who are willing to invest in food security, but do not have the resources for it. On the other hand, there are parties who do have the resources, but are less willing. Therefore, an environment where the former parties get resources to invest through subsidies from governments or investments of companies might provide those parties with the resources they need. Furthermore, the latter parties need to have incentives to invest in the parties which do not have sufficient resources by making these investment projects more attractive. Another thing which may improve global food security is establishing a committee that directs issues around this theme. A committee could regularly review the current situation and plan what needs to be done in the future.

This paper examines the effect of a boss in a team on cooperation. This paper combines the literature about the need of a boss in a
team and the literature about public good game experiments. To investigate this, a hypothetical experiment will be conducted among students and compared in a team with and without a boss.

**Cooperation**

Fehr & Gächter (2000) investigate cooperation and free-riding in a public good game. A public good game is a n-player prisoners’ dilemma game. Each player has an endowment and needs to decide how much to invest in the “public good” and the rest in the “private good”. The game is set up in such a way that it is a subgame perfect Nash equilibrium to invest only in the private account. However, there is also an equilibrium with a higher outcome if all players invest in the public account. Fehr & Gächter are interested whether giving subjects the opportunity to punish may improve the degree of cooperation in a public good game. They employ a “stranger” and a “partner” treatment, where both treatments are compared in a situation where subjects do not have the opportunity to punish each other and a situation where such opportunity is present. The average contributions are much higher in the punishment situations compared to the situations with no punishment opportunity. In the former situation the average contributions follow a stable increasing pattern, whereas in the latter situation the average contribution decline and converges to a level just above zero. Gürerk, Irlenbusch & Rockenbach (2006) extend their research by giving the participants the choice to choose an institution with or without punishment opportunities. Comparable results are found for the two treatments. However, gradually more people voluntarily switched from the sanction-free institution to the sanctioning institution. The results of these two studies display contribution levels, which are contradictory to the standard economic view. This view assumes people to be self-maximizing and therefore should contribute nothing at all to the public good in both situations. Several studies explained these contributions by the fact that people hold heterogeneity of preferences (Fischbacher, Gächter & Fehr, 2001; Fischbacher & Gächter 2008).
Alchian & Demsetz (1978) argue the need for an institution called the firm. Alchian and Demsetz review team production and advocate the urge for the firm, in which one person should monitor the members of the team to ensure they do their job well. To provide the monitor with incentives to do his or her task as well, this person has to be the residual claimant of the results that come from the team.

**Method**
A vignette, a hypothetical experiment, is conducted for this research. A fictive description of a situation is described where three people need to work together. Participants are requested to give advice to one person in the story with respect to the amount of effort to put in the team. This research contains two treatments, which are “centralized” and “decentralized” treatment. In the former a team is directed by a boss and in the latter there is no boss. Each treatment has three variations. The prediction is that the contributions in the centralized treatment will be higher than in the decentralized treatment. The hypothetical experiment is administered by 279 students.

**Results**
People in the centralized treatments exert a higher level of effort compared to people in the decentralized treatments. A Wilcoxon rank-sum test showed that these results are significant.

**Conclusion**
This paper examined the effect of a boss in a team on cooperation. The results showed that the cooperation levels are higher in a situation with a boss than without. This study illustrated that one institution might be better than the other. To improve global food security this may hold as well. Cooperation may result in higher achievements and prevent food shortage.
References


Biting the hand that feeds us: urban planning at the front line in the war against unhealthy eating

Jennifer Kent
University of New South Wales

Introduction

Although food is a fundamental human need, the way food is consumed in many developed countries is contributing to alarmingly high levels of preventable disease (Jeffery & Utter, 2003). High intakes of energy, saturated fat and salt, as well as low fruit and vegetable intake, increase our risk to ‘lifestyle diseases’ such as cardiovascular disease, type II diabetes and cancer (Donovan et al, 2011). In addition to placing a burden on public health care systems, these diseases result in considerable loss of quality of life to the individual, and place stress on impacted families and communities.

Environmental interventions to ensure access to healthy food are part of a multifaceted, preventative approach to combat poor eating habits as a risk factor to disease (Feng et al, 2010). Primarily through the planning function of land use regulation, urban planners can influence food production, retailing and advertising environments to support healthy food choices. Protecting urban agricultural lands (Merson et al, 2010), permitting farmers markets (Larsen & Gilliland, 2009) and community gardens (McCormack et al, 2010), prohibiting the formation of clusters of fast food outlets (Austin et al, 2005), supporting the development of supermarkets and fresh food retailers (Ashe et al 2007; Kent et al 2011) and regulating food advertising environments around schools (Kelly et al, 2008) are examples of how urban planning can promote healthy eating. This ability has played a role in a contemporary reinvigoration of an interdisciplinary relationship between health and urban planning, with planners across the globe embracing the opportunity to assist health professionals in the fight against poor nutrition.
Sampling findings from a recent review of contemporary empirical research, this paper will focus on the impact of food retailing environments on health and conclude with recommendations for future research.

**Convenience, access and healthy eating**

Increasing urbanisation, often characterised by low density, homogenous and car dependent built form, has placed the convenience of access to food within the neighbourhood as a central determinant of our food choices and patterns of food consumption (White, 2007). Our sprawling urban landscapes ensure the precious snippets of time between conflicting commitments are often dedicated to rushing across increasingly congested cities (Urry, 2007). Indeed, lack of time to purchase and prepare healthy food is often cited as a barrier to healthy eating (Coveney & O’Dwyer, 2009; Paquet et al, 2010) and one that seems to have been passed down to younger generations (Crawford et al, 2008).

The built environment has an important role to play in both providing and promoting convenient access to healthy food (Powell & Bao, 2009). The geographical structure of food retailing environments shapes accessibility to supermarkets and fruit and vegetable stores, and the variety and price of foods within these stores (White 2007; Coveney & O’Dwyer 2009). These environments also determine exposure to the energy dense foods often featured in convenience stores and fast-food outlets (French et al, 2001).

There is a burgeoning body of literature both confirming and refuting the relationship between the types of food available in the immediate residential neighbourhood and the food we choose to eat.
For example:

- Dengel et al (2009) collected health data from 188 adolescents in Minneapolis-St Paul, USA. Individual place of residence was mapped against proximity to convenience stores. A consistent inverse relationship between metabolic syndrome and distance from residence to convenience store was revealed.

- Galvez et al (2009) conducted a similar study on 323 children in the State of New York, USA. They were able to conclude that children living on a block with one or more convenience stores were more likely to have a higher body mass index compared with children living in blocks without convenience stores.

- Li et al (2009) undertook a quasi-experimental study of one year change in body weight in 1,145 adult residents in Portland, USA. The study revealed that neighbourhoods with a high density of fast-food outlets were associated with increases of 1.40 kilograms in weight.

- Zenk et al (2009) examined access to food stores and fruit and vegetable intake in 146 neighbourhoods in Detroit, USA. Their study found that the presence of a large grocery store in the neighbourhood was associated with consumption of more daily fruit and vegetable servings.

- In a smaller sample of 102 households, Bodor et al (2008) examined the availability of fruit and vegetables in all shops, from small corner stores to supermarkets, in Louisiana, USA. They were able to quantify that greater fresh vegetable availability within 100 metres of a residence was a positive predictor of vegetable intake and that each additional metre of shelf space dedicated to fresh vegetables was associated with 0.35 servings per day of increased intake.

In contrast to literature confirming a relationship between food access and health, is evidence to the contrary. For example:
• Pearce et al (2009) mapped travel distances to the closest fast-food outlet for all neighbourhoods against the results of a national health survey in New Zealand. The study found that residents in neighbourhoods with the furthest access to a multinational fast-food outlet were more likely to eat the recommended intake of vegetables but also more likely to be overweight.

• Wang et al (2007) assessed access to supermarkets for 7,595 adults in California, USA and found that having good access to chain supermarkets was actually related to a higher BMI for women.

• Using a longitudinal quasi-experimental approach, Cummins et al (2005) examined the impact of a large retail centre in a deprived neighbourhood in Glasgow, Scotland. Adjusting for age, sex, educational attainment, and employment status, the study found no change in daily fruit and vegetable consumption over the 12 months following the increased exposure to food choice provided by the new retail centre.

• Returning to fast-food, Sturm and Datar (2005) found that fast-food restaurant density was unrelated to weight gain over four years in a nationally representative cohort of kindergarten children in the USA.

These studies are a small sample of published evidence for and against using land use regulation to encourage healthy eating (for a systematic review of other literature in this area, see Kent et al, 2011).

**Moving forward: Recommendations for future research**

There is a logical link between exposure to healthy food options and healthy eating, with preliminary research suggesting that this link persists across traditional demographic boundaries, including age and socio-economic status. Attempts to quantify this relationship, however, have been based on mixed methods and have produced mixed results. This is particularly so for
environments outside the USA (as discussed in detail in Cummins & MacIntyre 2006).

The mixed results prompt consideration of the possibility that there is a strong cultural attachment to the way food is purchased and consumed. The built environment’s ability to provide healthy food options is potentially very sensitive to the specificities of cultural and social norms within place. Exploring the sensitivity of this relationship requires qualitative, culturally relevant research which is more attuned to the idiosyncrasies that define our complex relationship with food – both its purchase and consumption. Development of a body of this culturally sensitive research, undertaken in different urban areas, will allow more reliable generalisations to underpin policy.

Contextualised studies should also incorporate analysis of smaller scale retail environments. Juxtaposed to large scale quantification of fast-food accessibility, detailed research is required on the kind of food choices available at all outlets. This research should include neighbourhood coffee shops, restaurants, supermarkets, convenience and corner stores, as well as take away food shops and fast-food outlets. To undertake this kind of detailed analysis, further collaboration with health professionals is required to better understand and develop standardised measures of what is an unhealthy food environment.

**Conclusion**

While the relationship between urban planning and food is not an obvious one, the link between the food we are exposed to and the food we choose to eat seems plausible. As a result, providing access to adequate, nutritious, safe and enjoyable food constitutes a central concern for the urban ‘planning project’ (Healey, 2010 p.16). Food provides the foundations for human flourishing and the fabric of our own sustainability. It lies at the heart of conflict and diversity, yet provides opportunities for cultural acceptance and respect. It can define neighbourhoods, shape communities and
Jennifer Kent
Biting the hand that feeds us: urban planning at the front line in the war against unhealthy eating

make places. The war against poor nutrition needs to be fought on all fronts. While there is evidence that planners can, and do, contribute to this battle, the use of land use regulation to encourage healthy eating needs to be underpinned by more contextual, place based research undertaken in collaboration with health professionals.

References


Jennifer Kent
Biting the hand that feeds us: urban planning at the front line in the war against unhealthy eating


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Introduction

The fifty years that followed the Second World War saw a sweeping transformation of British society’s attitudes towards race, the social status of women, and even (arguably) the class structure. This marks out the post-war period as one of the most distinctive eras of British history, yet during this time an altogether quieter transformation was occurring in the homes and bodies of the British people. Since the end of the war there has been a fundamental shift in our economic, cultural and social relationship with food - which has been written on the bodies of the population through a rising tide of obesity.

From scarcity to abundance

This case study explores how British society responded to the end of rationing and the growth of unfettered consumption. Consider, for instance, that during the Second World War, Britain - one of the most prosperous nations in the world - had to deal with widespread food shortages and resorted to rationing the consumption of individuals to compensate. Despite these limitations however, it was noted during the Second World War, (Tokens of Health 1941) and has been corroborated by historians since (Zweiniger-Bargielowska 2000, p.44), that the nation’s health was improving, because for the first time, entire swathes of the country were guaranteed to receive the basic minimum required to sustain an individual. Therefore, social concerns over food were, and had long been, focused on ensuring the sufficient provision of nutrition for the entire population (Webster 1985, p.215).

Yet by 1970, within fifteen years of the end of rationing, the discourses surrounding food, health and nutrition within mass
media, the medical community, and the state had shifted. Rather than relating to concerns over mass hunger and malnutrition, the debate had moved on to the dangers of mass obesity resulting from the oversupply and overconsumption of food. This represented the first time that Britain (and indeed any nation) had to deal with the consequences of a society that could - en masse - consume food with few restrictions. As the incidence of obesity grew, the cultural associations of the obese person changed. By the 1960s the main thrust of discussions over obesity no longer focused on altering the behaviour of the middle-class manager (who was invariably male) but on educating the working-class mother (*Increase in Fat is Worrying Doctors* 1967). This reflected not only a fundamental shift in the age and social class of those considered most at risk, but also a shift in the persons considered responsible for the growth in obesity. Now, fifty years later, obesity is a problem that concerns not just a few privileged Western countries, but those all over the industrialising world; at present, 24.2% of Mexico’s population are clinically obese - second only to the US, which has an obesity rate of 30.6% (OECD 2005, p.2).

**Society and food in the UK up to 1970**
The evolution of British society’s relationship with food from one of scarcity to one of abundance had the power to influence not only how British society viewed itself, but also the wider world. It seems no coincidence, for instance, that Oxfam (originally the Oxford Famine Relief Committee) was established to help deal with the problems of famine in developing countries in the post-war period. The dedication of resources to those struggling for food is symbolic of a country confident of its own food security; as the problem of food scarcity became a distant memory, we moved culturally away from recognising these issues in our own society. This allowed food scarcity to become a marker of the problems of ‘other’ (poorer) nations in need of help or charity, thus underlining the fact that abundance allowed British society to re-orientate how it viewed itself within the world community.
The intention of the present research is to provide an historical dimension to this most contemporary of debates and issues, and the period 1945-70 provides an excellent case study of a society experiencing a transformation in terms of its relationship towards food. Through an analysis of parliamentary papers, newspapers and medical literature of the period it is possible to trace development of concerns (during the late 50s and early 60s) over the relationship between overeating and serious health problems - such as heart disease and diabetes. This raised necessary questions over the role and responsibilities of the state, especially regarding preventative measures, and the responsibilities of individuals to monitor their own (or in instances of childhood obesity, other people’s) food consumption.

The social history of an ‘Epidemic’
This project will employ oral history to synthesise to development of an understanding of how public discourses regarding the rise in obesity influenced personal eating patterns, food choices, and attitudes towards health and the body; the ‘hidden’ history of this quiet transformation. The relevance of this study for contemporary international research on food and health is exhibited in two main ways. Firstly, it provides opportunity for those countries currently struggling with their own increasingly overweight and obese populations to ask what lessons can be drawn from the British experience regarding, for example, preventative public health measures. Secondly, upon completion of this project, these documented personal histories will provide an indication of the private costs and difficulties that result from an ‘epidemic’.

The major implications of this project are that researchers interested in the contemporary issues of obesity can begin to unravel the complex social, cultural and economic issues that surround the phenomenon of obesity. This is especially pertinent for public health professionals wishing to intervene in or alter the social, cultural and economic contexts that influence the development of an ‘epidemic’. Globally, as traditional diets are superseded by western, convenience based, eating patterns, the
story of economic and social ‘development’ is being written of the bodies of the world’s population. An historical context will shed light on the age-old problems of the supply, demand and consumption of food.

References

*Increase in Fat is Worrying Doctors* 1967 *The Times* From Our Medical Correspondent June 2nd, p.4.


*Tokens of Health* 1941 *The Times*, Editorial, August 20th.


This paper will discuss local practices and attitudes to radiated food consumption in economically-marginalised communities that border the Chernobyl ‘Exclusion Zone’ in Ukraine. Fitting into key debates about food in relation to trust, risk perception and state-society relations, this paper will situate these in a landscape where invisible radiation reverses the cliché that ‘what you can’t see, won’t hurt you’.

Despite recent alarming events in Japan, the 1986 Chernobyl catastrophe remains the worst technological accident in nuclear energy’s brief history. Chernobyl is an unusual disaster, having been compared to the HIV crisis which is both geographically and temporally uncontainable (Ophir 2003). Both HIV and Chernobyl radiation affect the biologies of individuals and can spread across borders in space and time. But unlike Aids, Chernobyl does not pose a health threat through bodily contact, but through consumption of the landscape itself – the water, the air and primarily - the food.

This paper is grounded in ethnographic fieldwork in the Chernobyl border region near the 30km ‘Exclusion Zone’ in north Ukraine. Participant observation and interviews were conducted with people who live in this rural and economically marginalised border region. Following de Certeau (1984) and Lefebvre (1984), the everyday lives of these people have been explored in order to understand the ‘tactics’ and ‘strategies’ used to negotiate life in a ‘contaminated’ region.

Food production, collection and consumption provide a salient way to examine the relationship not just between the landscape and
the body, but also between state and society; a lens through which the invisible threat of radiation may be explored. Indeed it is the invisible characteristic of radiation which makes it such a modern and incomprehensible threat in our ‘Risk Society’ (Beck 1992); it is undetectable to human senses. “Post-Chernobyl eating can pose risks to health” (Phillips 2002, 6) yet a clean mushroom tastes identical to a ‘dirty’ one. Radiation danger is therefore highly mediated (Kuchinskaya 2007). Mediated, some argue through the lens of the “scientific gaze” (Bourdieu 1990, 382), with its technocratic equipment and cartography; filtered through the “eye of power” (Foucault 1980). Chernobyl dangers are imaged and re-imagined, transferring them from the invisible to the seen and hopefully, understood. But with this comes issues of (mis)trust. The fact that the state and it’s science has created not only the original problem of Nuclear meltdown, but also controls all the means of detecting and articulating the resulting danger, has put strain on state-society relations.

This strained relationship plays itself out in the everyday actions of the economically marginalised who live with the after-effects of the Chernobyl accident. For example, one babushka (old woman) who lives in a village adjacent to the ‘dead zone’ around Chernobyl explained how:

‘After the tragedy many people...liquidators and people who live in this zone organised a meeting and [the government] said that you should not eat this one, or that one, or this one... etc etc cucumbers, milk...you name it...But if you are not going to drink or to eat everything that they say, then you won’t even have the energy to move even your legs...you’ll have no power to even move your legs...’

Indeed the vast majority of my participants freely admitted that they regularly ate food that is either officially illegal (from within the ‘zone’) or not recommended, such as wild mushrooms and berries.
However this was not done through a belief that Chernobyl radiation is risk free; many in this region have personal narratives and experience of death, loss and tragedy associated with the accident.

There exists a burgeoning literature in the field of rural geography focussing on ‘alternative food networks’ (AFN), often, as suggested by Round et al (2010), over romanticising the concept. There are few more alternative foods than those plucked from the radioactive soils and rivers within (and without) Chernobyl’s official sphere of influence, to be traded though barter, gift, and social networks (Pavlovskaya 2004) and to arrive street-level at the top of metro staircases in the bustling heart of urban Kyiv. Or, as is more visible, to be consumed by the local inhabitants of the Chernobyl border region; not in a ‘grow-your-own’ act of romanticised rural-defiance, nor in denial that radiation is a very real and harmful thing; but simply to survive. It is apparent in this region that “for rural inhabitants the challenge is survival” (Unwin et al 2004, 127). Indeed poverty is a big issue here.

My findings also show that in relation to food, ‘local knowledge’ is often privileged over official state advice. For example one man who was catching fish in the river that runs past the “most contaminated water body in the zone of the Chernobyl accident” (Kryshev 1995) told me how we were too close to Chernobyl for it to pose a danger:

‘It all blew over the sky after the explosion and did not fall down immediately. It spread over some kilometres. Only after that did it fall down to the ground. It’s physics!’

The many holes made in the barbed wire fence that surrounds the 30km exclusion zone, speak to the fact that this porous border is often crossed using local knowledge, with many interviewees saying how they ‘know best’ where the invisible radiation is. Furthermore the mushroom pickers and hunters who take food
from the exclusion zone also describe how border guards can be overcome through ‘informal means’.

The conflict between the survival tactics of the rural poor, versus the state’s strategies to mitigate against the ongoing risk from Chernobyl radiation is a revealing one. One can argue that the very laws that are designed to protect the health of communities in contaminated territories, contribute to the problem of survival for the rural poor in this region. Food, as a central component of everyday-life, is an engaging way to reveal these tensions.

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Thom Davies
Nuclear mushrooms: attitudes to risk and the state through food consumption in the Chernobyl border region

Eating
Syrian family meals are an array of homemade preserves and dishes eaten with locally bought flatbread. Each contains constellations of taste, nurturing and ‘generation’. In this paper, ethnography of Damascene foods is presented to show why ‘top-down’ presumptions of state policy food distribution are reconfigured by an anthropological approach. Comparing political context with socio-cultural food practices reveals policy operating within Syrian historical self-construction and contested meanings of food which Damascenes make (cooking) and which make them (eating).

Bread
In 2001, ‘Bread before Freedom’ was the defining maxim of Syria’s new President Bashar al-Assad (George 2003, p.55). Damascenes often refer to bread as ‘aish’ (life) remarking ‘two kilos of bread per day feeds a family of six’. Wheat, irrigated by the Euphrates and governmental engineering initiatives, is Syria’s staple (Khalafa 1991; OBG 2008). Thus bread symbolically resonates between historical and contemporary, political and personal (Borneman 2007). Following President Hafiz al-Assad’s death in 2000, hope was ignited for a new reforming politics. A year later, the ‘Damascus Spring’ was quelled. The regime continued to dominate its malcontents: economic reform was to be the priority over political reform (Pace & Landis 2009). The state remained the primary controller of the means of production (OBG 2008; Haddad 2009) by emphasising food provision fears lodged in collective memory from periods of political upheaval resulting in starvation around the two world wars (Thompson 2000) and by more recent Israeli control of water resources in the Golan Heights (Petran
1972). The Ba’athist regime utilised ‘bread’ as a powerful political symbol and materialisation for its policy of ‘change within continuity’.

Recent unrest and revolution in the Middle East can be seen through the lens of generational conflict over resources, production and consumption (Muñoz 2000). In 2000-1 Syria’s biggest age-cohort generation were children and adolescents (CIA World Factbook 2011). Now, as adults they are increasingly frustrated by their limited life prospects and means of control, while political manifestations are unclear. What ethnographic research reveals are the contexts and subtleties of day-to-day life animating Syrian society. Ethnography allows us to invert political maxims by examining the familial relationships at the root of the ‘generational conflict’ metaphor (Robertson 2001). The culturally specific process of generating and nurturing through food constrains governmental policy, while the social and sensual regimes articulated generate political volition (Lévi-Strauss 1966; Appadurai 1981).

Preserves
Many poor Damascenes disdain subsidised tokens and government shops not because they reject state-policy but dislike the taste of the produce. Great effort is put into food preparation, as illustrated by the production of homemade preserves and pickles. Although readily available, bought produce is always less preferable than homemade preserves. The time embodied in creation of preserved foods highlights that labour contains transformative and lasting ability to leave discernable consequences (Arendt 1958).

Consumption of preserves by kin is integral to the process of ‘generation’ and their labour-intensive production enhances their nurturing capacity. The quality of such pickles defines the work they perform: ‘You love us as much as you eat!’ families would exhort, insisting I eat copious olives carefully treated by daily water changes over months. Eating hand-sweetened olives was part of the reciprocity of senses their oily flesh contained, as intended by my hosts: as I ate sweet olives I too became sweeter,
literally through the food and also in my hosts’ perceptions (Cowan 1990). Thus the taste homemade food is integral to its role in nurturing relationships.

Transporting home-preserved foods is how families try to mitigate processes of deracination by extending commensality (Carsten 1997). Syrians continually transport quantities of preserved food to gift elsewhere. I shared one long bus journey with hoards of edible luggage. Surrounded by large bottles (4-5 litres) and industrial tubs filled with pickles, I asked their diminutive chaperone if she planned to sell them: ‘No,’ she scoffed, ‘it’s for my family, everything’s so expensive in Istanbul, Syrian things are much cheaper. Besides I couldn’t go without a present’. I replied that I hoped she had strong relatives to meet her in Istanbul! ‘Of course,’ she laughed, ‘I’m visiting my son and some of my nephews are there too, they’re very strong because I fed them!’ The equation was clear: the economic, sensual and affective sides of nurturing were elided. The preservation of food helps to preserve kin-ties by animating a sensual regime of taste, origins, memory and kin-work (Sutton 2001, p.75).

**Taste & smell**

Preserves pervaded Damascene homes with fragrant smells, which elicited memories from my informants. Reminded by the scent in their kitchens, old women related fragments from their pasts: the death of a child; times their father carried them, his coat sheltering them from the snow. While consuming these foods, family members would share memories and situate personal events in the broader political milieu they evoked. The olfactory perception associated with preserves illustrated processes of personal history making (Scholliers 2001). The senses pervade and diffuse material culture as saturated with historical perception, evoking Seremetakis’ question: what is preservation of food if not ‘the maturation that takes place through the articulation of time and substance?’ (1996, p.3). In Damascus the ‘substance’ can be seen as the food ingredients and the human endeavour of work that is transformed by the time it takes to preserve foods. For
Damascenes, the ‘articulation’ of time and substance, their point of interaction, is one of a culturally specific set of tastes and smells.

**Concluding remarks**

A Damascene meal is a combination of state-controlled bread and homemade preserves. Both foods nurture the biggest age-cohort generation, literally, and metaphorically as aspirations through the familial memories and knowledge they bestow (Bahloul 1996). The social and sensual regimes of taste and smell generated via food alert us to the possibility that for Damascenes, there may be more compelling realities than the demographic phenomenon of age-cohort, to which collective ideas and actions around production and consumption of food are ascribable. Thus conceptions of taste, nurturing and generating emerge as paramount socio-cultural factors in the realisation of the means of production and food policy.

**References**


Bethany Honeysett
Food for generation: Regimes of taste and nurturing in Syria

Agroecology, control and an indigenous community's 'Food Circle': Confronting precarity in Ecuador's Andes

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Introduction: Collective enterprise
This paper looks at a food-system initiative designed and implemented by members of an Indigenous community in central Ecuador²: a 'Food Circle' which, by localizing food production, distribution and consumption, ties together efforts to counteract the precarious nature of local employment and fluctuating food prices. This collective action, I suggest, both contributes to strengthening community cohesion, and illustrates how forms of 'food sovereignty' can address some of the clear inequalities of our globalized food system.

The global: paradox and power
The global food crisis - the paradox of hunger in a world which bears a global agriculture capable of feeding 12 billion people (v. Gasperini & Maguire 2002; Ziegler 2001; van der Westhuizen 2008) - is often presented as a shortage of food in relation to a growing population. Along with others, however, Lappé argues that naming a scarcity of food offers an incomplete explanation of the origins, the perpetuation and the deepening of the 'crisis': moreover, that resolving this paradox lies in distinguishing between a lack of food and a lack of power, between the symptoms and causes of hunger (Lappé 2008).

In the case of small-scale farmers in locations throughout the world, including in Ecuador's Andes, the need for power includes the power to opt out of, control or influence any market systems

² In the Andean province of Cotopaxi.
that affect their access to food, the power to decide what crops they themselves shall grow and in what quantities, and the power to define and direct the destinations of what they produce.

The national constitution and agroecology

Sub-regional level actions to move in this direction of increased producer-control over food systems in Ecuador now take place in a political climate where the national government, through a new Constitution in September 2008, nominally supports the idea of 'Food Sovereignty'. These activities strengthen the call, echoed by many ecological groups and farmers' movements alike, for food production nationwide to be 'agroecological'.

Broadly speaking, 'agroecology' combines an opposition to industrial approaches to agriculture with methods that follow organic or low-external-input practices, promotes biodiversity and the integration of 'traditional' knowledge, and extends these concerns out into the social sphere (looking at the longevity of the lives and collectivities of food producers). These practices are promoted in the village under consideration here, where a large poster hanging in the communal meeting hall reads "San Isidro - Declared An Agroecological Community".

The Comuna and the Food Circle

It is against this background of national-level changes and activity...
that work in the largely semi-subsistence indigenous 'comuna' (community) of San Isidro takes place, cultivating a variety of traditional and staple crops\(^6\) on small landholdings irrigated by rainfall and the comuna's own irrigation system. Around 500 people in 84 families live here (OPIJJ 2009), where the landscape begins to rise from Ecuador's central Andean plain up into its Western slopes.

A recent initiative has given rise to weekly exchanges in the village square among a collective of food producers. The idea was outlined initially in economic terms: "rather than, say, ten families all going to Pujilí [the nearest market town] each week and each spending $10... they stay here and these families make a wheel, or circle, of produce [a 'food circle']... that way, staying here, there is $200 in San Isidro that was not gong to be there otherwise..." (encuentro, 1902117). The events themselves bring together families (mainly women and children, since most men travel away to work), where deals are quickly struck and plans discussed for what might be available next week, with some variation in attendance (since not everything is ready for a weekly harvest). Access to food is thus more directly negotiated (in contrast to the global inequities in food distribution), and the destinations of crops agreed among the producers themselves.

**Precarious work - Collective safeguards**

Whilst much of the work of the Comuna is focused on retaining or regaining control over territory, identity\(^8\) and food production, the village experiences some marked economic realities which perhaps sit uneasily beside these efforts - principle among them is the

\(^6\) Crops grown include: maize, potatoes, onions, beetroot, lettuce, carrots, beans (and among them are fruits of various kinds including taxo [papaya] trees, and mora [blackberries] bushes).

\(^7\) Dated quotations come from the author’s fieldnotes.

\(^8\) Including practices of 'indigenous justice' and a sense of morality based on "trust, favors, and respect" (Cruz 1997:11).
largely migratory male population\(^9\) traveling to shift-work jobs in the petrol industry. Nearly all contracts are temporary, and recently there has been a spate of contracts not being renewed, leaving many San Isidro residents unemployed and seeking alternative employment.

This uncertainty regarding work reflects global trends in the increase of 'precarious' jobs, a 'precarity' which is said to be found virtually 'everywhere' (Bourdieu 1998: 96 ff.), but which is not an "inherent necessity" since "collective safeguards" (Dörre 2006; cf. Kok 2004) can be developed to address subsequent challenges. The 'Food Circle' appears to offer one such safeguard in the context of uncertain paid employment, providing both a more dependable market (than other local markets attended by both producers and merchants alike) for the small amount of produce being grown (as a source of income), and an opportunity to directly negotiate the purchase-price of staple crops.

**Communal appropriation, community control**

The Food Circle also involves the same people - various members of the comuna - who, with their collective labour, are jointly responsible for maintaining the village's irrigation water system, and its source at the end of a 20km pipeline up in the 'páramo' highlands. This further solidifies the mutual 'investment' in, and control over, village agriculture among comuna residents, and also echoes Nigh's argument that a strategy critical to the (economic) survival of similar rural populations is a “communal appropriation of the productive process and of the commercialization of their products (Nigh 1992)” (Nash 1994: 17)\(^{10}\).

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\(^9\) Elsewhere in the Sierran highlands, there is work in the floriculture industry or with companies producing other "nontraditional or new traditional exports" (Sawers 2005), such as on broccoli plantations: both export industries operate in the area around San Isidro, but the village appears to be locally quite unique in the number of men there who travel to work in the petrol industry in the Amazonian oil fields.

\(^{10}\) It also secures the consumption of carefully managed natural resources such as water by avoiding exports: "Few people, when they slice up a
Conclusion
By maximizing community- and producer-control over food prices and destinations, the Food Circle provides a model for national Food Sovereignty whilst also securing income to compensate for precarious local employment practices. It complements existing efforts to collectively manage natural resources crucial to crop cultivation in the village, and further promotes the principles of agroecological agriculture. By thus governing both productive and commercial processes, participating comuna-members in San Isidro can better safeguard their access to food.

References


tomato... or tuck into an apple, give a thought to the amount of water that went into the production of those foods. But the water that we consume indirectly, through the food we eat and goods that we use, dwarfs our water consumption for drinking and washing... About 70 per cent of the water consumed by people in the UK, for example, comes from overseas, according to Waterwise, a UK government-funded body" (Harvey 2007).
Tristan Partridge
Agroecology, control and an indigenous community's 'Food Circle':
Confronting precarity in Ecuador's Andes


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Introduction

Participatory approaches have become popular in Indonesian agricultural R&D (Hariano, 2007) replacing top-down transfer-of-technology models predominant a decade ago (Thorbecke & Van der Pluijm, 1993; Van der Eng, 1996). Despite relying solely on national research centers to provide agricultural technologies to improve production systems in various agro-ecology zones, the Indonesian Government established Assessment Institutes for Agricultural Technologies (AIAT) in every province to conduct adaptive research (TAKE - technology assessment and knowledge exchange) in farmers’ fields to assess the suitability of innovations developed by national research centers under local conditions (Permentan, 2008).

There is a growing concern regarding the effectiveness of current TAKE approaches applied as they do not always lead to increased agricultural productivity nor improved livelihoods of smallholder farmers. Partner farmers in TAKE activities often abandon new technologies and return to previous practices once the project finishes (ACIAR, 2008) due to the unsuitability of the technologies, and difficulties to access required inputs for sustained implementation of the technology. There are, however, more successful pockets of activities from which important lessons can be drawn to understand what approaches towards TAKE lead to better impact. This paper analyzes the TAKE processes applied in three different projects in Eastern Indonesia, and specifically looks
at the contribution of these processes toward long-term practice change by farmers leading to improved smallholder livelihoods.

**Methodology**

Comparative case study methodology (Yin, 2003) was employed to assess three TAKE projects in Eastern Indonesia. This methodology was chosen because it enabled the investigator to explore phenomena in which the investigator had no control over the events (Marshall & Rossman, 2006). Three projects targeting farmer practice change in beef cattle production were selected based on different initiation process; different funding sources; and differences in the underlying philosophy towards farmer engagement.

Study was focused on project methods/processes and the contribution these processes had on delivering impacts on farmer’s livelihood. Meanwhile, project impacts were assessed using a modified sustainable livelihood impact assessment (Adato & Dick, 2002). Qualitative data were collected through direct observation, focus group discussion and in-depth interviews using several participatory techniques (Bryman, 2004; Chambers, 1994; Marshall & Rossman, 2006). Data were analyzed using phenomenological thematic analysis using NVivo software (Holloway, 1997; Richards, 2009).

**Results and discussion**

**Different philosophies, different processes**

An overview of the three case study projects, the processes they applied and achievements they gained is presented in Table 1. Although all projects claimed to apply a 'participatory approach', this study found the projects engaged farmers in different ways resulting in different degrees of participation and ownership over process and outcomes. Project 1 departed from a predefined technology package to be implemented by participating groups who only had limited opportunity to adapt the technologies. The
technology was demonstrated at a model group and farmers were regularly visited by field staff advising how to apply the package. Farmer involvement was mainly employed to support the dissemination of that technology package.

Similarly, Project 2’s intention was to use participating farmer group to test several predetermined technologies. Nonetheless, it provided more scope for the farmers to modify the technology to meet their conditions. The project operated through engagement of an elite group of partner farmer group with expectation these “champion” farmers would transfer the technology to other farmers. Project communications were mainly directed to the group leader and selected “champion” farmers. Both projects 1 & 2 focused on working with individual key farmers with little effort to build linkages with or develop support capacity of Indonesian extension providers at the local district level, implicitly limiting dissemination beyond the project villages.

Project 3 was different in that the project team undertook a detailed situation analysis of the target communities prior to designing project activities. Results were then taken to a project design workshop attended by all stakeholders. All stakeholders were clearly assigned roles and responsibilities within the project that complemented their capacity. Thematic training was organized to improve farmers’ capacities on technical and farm management issues, and improved practices were implemented (and adapted) by all participating farmers in their own fields.
Table 1: Description of the three case study projects and their impacts

<table>
<thead>
<tr>
<th>Process</th>
<th>Project 1</th>
<th>Project 2</th>
<th>Project 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title</td>
<td>Scaling out herd management strategies in Lombok</td>
<td>Management improvement for Bali cattle under grazing system in East Lombok</td>
<td>Improved management of integrated maize-cattle farming system in Kupang</td>
</tr>
<tr>
<td>Funding agency</td>
<td>Australia Centre for International Agricultural Research</td>
<td>The National Government originally from World Bank loan</td>
<td>Australia Centre for International Agricultural Research</td>
</tr>
<tr>
<td>Objective</td>
<td>To improve household welfare by initiating adoption of better husbandry management of Bali cattle in Lombok</td>
<td>To demonstrate technology package of improved Bali cattle management.</td>
<td>To design and pilot on small scale the development model of integrated maize-cattle to improve farmers’ income to own cattle.</td>
</tr>
<tr>
<td>Type of participation</td>
<td>Consultative</td>
<td>Consultative</td>
<td>Collaborative</td>
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</table>
### Impact:
- **Scope of practice change**
  - Restricted to the partner group.
  - Composting practice spread widely (from 40 trainee to around 800 followers).
  - Practice of other technologies ceased.
  - Wide spread of practice change until neighboring villages.
  - Model adopted by stakeholders.

### Financial impact
- Bulls from the project has reduced calving interval period hence saved farmers’ time and labor.
- Homemade compost has reduced costs of vegetable production.
  - Reduced calf mortality rate from 80% to 20%.
  - Faster cattle growth rate.
  - A dramatic increase in maize production has enabled farmers to buy livestock.
  - Now higher return from selling young corn.

### Human impact
- Improved knowledge of cattle management but did not want to share it.
- Improved knowledge of cattle management but shy to share it.
  - Valuing cattle manure.
  - Improved group organizational skills.
  - Improved knowledge of maize farming, confident and willing to share it.
  - Changed behavior of selling corn for higher return.
Technology assessment and knowledge exchange processes for sustained impact in agricultural research for development: a comparative case study in Eastern Indonesia

<table>
<thead>
<tr>
<th>Process</th>
<th>Project 1</th>
<th>Project 2</th>
<th>Project 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social impact</td>
<td>- Strengthened collective action in certain groups but in reverse in other groups.</td>
<td>- Now penned cattle reduces the risk of crops destruction in the community.</td>
<td>- Became teachers for counterparts.</td>
</tr>
<tr>
<td>Unpredicted impact</td>
<td>- Missunderstandings between project staff and field extension agents undermining collaboration.</td>
<td>- Missed opportunity to spread technology using field extension agents.</td>
<td>- Excessive maize drove down grain prices decreasing farmer motivation to adopt practice change.</td>
</tr>
</tbody>
</table>

Different processes, different impacts

The very different levels of impact achieved by the projects can be explained by the processes of 'participation' of stakeholders in the development and implementation of project activities. In line with the typology of participation developed by Biggs (1989) cited in Okali and Farrington (1994), the involvement of stakeholders in Projects 1 and 2 fall under 'consultative participation' where researchers consult farmers to diagnose their problems and determine the solutions. In contrast, significant active involvement of all stakeholders in Project 3 falls under 'collaborative participation' where researchers, extension agents and farmers are all partners and collaborate in the research processes.

Results from the project impact assessments revealed that more intensive stakeholder participation in planning processes resulted in a greater sense of ownership over achievements, followed by
faster, more sustainable and self-motivated practice change. Sustainable practice change is likely to lead to higher agricultural productivity, in turn enhancing farmers’ livelihoods. Other similar studies (Chambers & Ghildyal, 1985; Maurya, 1989; Rhoades, 1989) have also found that providing space for farmers’ innovation and adaptation will not only generate adapted technologies but also enable wider and more sustainable adoption in other comparable agro-ecological and socio-economic environments.

Conversely, agricultural R&D projects with rigid technology packages tend to benefit better-off farmers because they have the resources to adopt the recommended technologies (Chambers & Ghildyal, 1985; Pretty & Chambers, 1993; Roling & Van de Fliert, 1998; Van de Fliert, 2008). Consequently, the technologies will remain inaccessible to the majority of poor smallholder farmers and their livelihoods will not be improved.

**Conclusions and recommendations**

Lessons can be learnt from the three projects that better engagement in planning provides more ownership and commitment over processes leading to more suitable outputs and self-motivated practice change hence more sustainable impacts on farmer’s livelihood.

**References**


Nurul Hilmiati
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Wheat grain quality at elevated [CO₂] under Mediterranean climate conditions

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University of Melbourne

Joe Panozzo, Michael Tausz, Robert Norton, Glenn Fitzgerald, Saman Seneweera
University of Melbourne

Introduction
Wheat is the staple food of almost half the world's population and it plays a significant role in global food security (Cakmak, 2004). World wheat production during the last 50 years has increased at an unprecedented rate, averaging 3.5% per year, indicating the fastest growth rate compared to other cereals (Simoni, 2009). The worldwide increase in both the area of cultivation and yield of wheat has been more rapid than for all other cereals combined. Thus technological innovation and scientific crop management with synthetic nitrogen fertilizer, crop protection chemicals, irrigation and wheat breeding are the main drivers for increases in the yield (Jaggard et al, 2010). Wheat is grown in diverse environmental conditions throughout the centuries and has adapted naturally or through breeding programs to cope with these varying climates while achieving increased yields alongside water and nutrient use efficiency (Jaggard et al, 2010).

The major forces driving the climate change are thought to be through the production and release of greenhouse gases such as carbon dioxide (CO₂), methane (CH₄), ozone (O₃) and nitrous oxide (N₂O) etc. Of these, CO₂ plays a major role and largely contributes to global climate change (Carter, et al, 2007). The present average CO₂ concentration [CO₂] in the atmosphere is 387 µmol CO₂ mol⁻¹. This concentration is rising and is expected to be 510-760 µmol CO₂ mol⁻¹ by the end of this century (Carter, et al, 2007). Similarly, atmospheric temperature is rising and is expected to be an average of 1.5-4.5°C higher than at present and there may be
more frequent occurrences of extreme climatic events such as heat waves and/or drought (Carter, et al, 2007). However, some of the negative effects of climate change may be offset by rising CO₂, as CO₂ is the primary substrate for photosynthesis (Drake, 1997, Seneweera et al, 2005, Ainsworth & Rogers, 2007). Increase in photosynthetic rates and reduced stomatal conductance can lead to increased carbon gain per given amount of water which improves the crop growth and yield particularly for C₃ plants (Nakano et al, 1997, Robredo et al, 2007).

On the other hand, elevated [CO₂] is known to modify the plant carbon (C) and nitrogen (N) balance, which occurs through changes in metabolism at the cellular to whole plant level (Seneweera et al, 2005). These changes could lead to adjustment in C and N dynamics in the whole plant and resulting change in the chemical composition of the vegetative and reproductive organs (Loladze, 2002, Seneweera et al, 2005).

Grain protein concentration is tend to increase with the high temperatures during grain filling which is one of main characteristic of Mediterranean climate conditions, for Australian wheat belt while high rainfall is associated reduction in grain protein concentration are documented (Randall & Moss, 1990, Correll et al, 1994). However, the effect of rising [CO₂] under mediterranean climate conditions on grain protein and nutrient relationship is not reported.

**Materials and method**

The experiment was conducted in the Department of Primary Industries Research Station, Horsham, Victoria, Australia (36°45′07″S, 142°06′52″E). The climate type of the area is classified as ‘Mediterranean’, but plant growth is somewhat slower compared to the typical mediterranean cropping systems (Hutchinson et al 2005). The experimental design was a randomized complete block split-split plot design with four factors and four replicates [CO₂] level, water level, sowing time and cultivar. There was eight ambient [CO₂] plots (12-m diameter) and
eight elevated [CO₂] rings (550 µmol CO₂ mol⁻¹) and 12-m
diameter, with two water regimes: rain-fed & irrigated; two sowing
times: “normal” or TOS₁ (starting late May) & “late” or TOS₂
(starting late June); two genotypes: Yitpi & Janz. Irrigation
treatment was imposed by dividing ring using polythene barrier to
avoid the water seepage between two areas, one side of the ring
was allowed for rain fed irrigation while other side was
supplemented with water. Temperature difference during grain
filling was imposed by delaying sown time, 4-5°C higher
temperature during grain filling at TOS₂ than at TOS₁. Most of the
other agricultural management practices carried out in this
experiment were similar to the area.

Grains were harvested at grain maturity. Total protein content in
whole-grain wheat were determined by Near Infrared Reflectance
Spectroscopy (NIR, Foss, Sweden) (AACC method 39-25) and was
expressed on 11% moisture basis. Grain protein concentration was
converted into grain N concentration by dividing conversion factor
of 5.7. Grain mineral concentration of macro and micro elements
were analysed using Inductively-coupled plasma atomic emission
spectrometry (ICP_AMS) (Applied Research Laboratories, 3580B,
Switzerland). Mineral concentration (mg kg⁻¹) was expressed on a
dry weight basis. Data were analysed with MINITAB 14 statistical
package using a General Linear Model analysis.

**Results and discussion**

Grain protein concentration was 13.8% under ambient [CO₂] and
13.1% under elevated [CO₂], showing a 5% reduction at elevated
[CO₂] (Table 1). This reduction of grain protein concentration is
smaller magnitude to reports from previous FACE studies (Kimball
conducted extensive literature review effect of elevated [CO₂] on
grain protein concentration where they argued that wheat grain N
concentration is decreased all the studied where lowest reduction
was 10% with an ample supply of N fertilizer suggesting that
reduction of grain protein concentration at elevated [CO₂] is not
directly linked to N supply some other regulatory mechanism exist
at whole plant level to control grain protein concentration at elevated [CO₂]. This lower reduction of grain protein concentration at elevated [CO₂] may be due to the different cultivar tested and different environmental conditions especially temperature and the soil water level that plant experienced during the grain filling.

Reduction in grain Fe, Mn, Mg, Na and S concentrations were observed under elevated [CO₂] (Table 1). Grain K concentration was increased at elevated [CO₂] while B, Cu, Zn, Ca, P and Al concentrations were not significantly changed at elevated [CO₂]. Elevated [CO₂] increases grain yield while decreases grain nutrient qualities including grain Fe concentration under mediterranean climate conditions. Alteration of grain quality at elevated [CO₂] will have negative effects on consumer’s health.

References


Jaggard, KW, Qi, AM & Ober, ES 2010,'Possible changes to arable crop yields by 2050'. Philosophical Transactions of the Royal Society Biological Sciences, vol. 365, no. 1554, pp. 2835-2851.


Introduction
Abiotic stresses caused by changing environmental conditions pose an increasing threat to sustainable food production. Over the last few years more than 50% of crop yields have been negatively affected by abiotic stresses (Vij 2007). About 6.5% of the world’s land (FAO, AGL 2000) and about 20% of the world’s irrigated land is adversely affected by soil salinity (Flowers 1995, Ghassemi 1995). The glycophytic plant rice is the world’s oldest domesticated grain crop and the staple food for about half of world’s population and suffers from 50% yield reduction every year even at moderate salt levels (Zeng 2002). Rice can tolerate salt stress by reducing the absorption of toxic ions, maintaining high cytosolic K⁺:Na⁺ ratio and reducing cytosolic Na⁺ load and compartmentalizing toxic ions into less sensitive organelles (Maathuis 1999, Blumwald 2000, Flowers 2008). Rice is more sensitive to salt at the seedling stage (Flowers 1981; Zeng & Shannon, 2000). Salt sensitivity in rice also varies considerably between cultivars, a phenomenon that can potentially be exploited to discover genes and proteins that contribute to tolerance (Senadheera 2009). Transcriptional expression of relevant genes under salt stress has been studied in few genotypes of rice shoots (Chao 2005 & Zhou 2007), roots (Kawasaki 2001 & Senadheera 2009) and whole plants (Ueda 2006 & Kumari 2009). The aim of this study is to conduct a thorough comparative transcriptomics study coupled with physiological approaches involving wide range of rice HYVs, cultivars and wild relatives with contrasting tolerance to salt stress which will better profile the
expression of associated transcripts in a way to understand the mechanism of salt tolerance.

**Materials and methods**

Seedlings of eight rice genotypes (Indica genotypes Pokkali, PSBRc50, IR 58 and BRRI dhan 29, Japonica genotypes Banikat and Nipponbare and wild relatives *O. latifoila* and *O. rupipogon*) with reputation to contrasting tolerance to salt stress were grown hydroponically using Yoshida nutrient medium (Gregorio 1997) under controlled conditions at 30/20 °C day/night temperatures, 100 µmol m⁻² s⁻¹ of irradiance for 16 h d⁻¹ and 60-70% relative humidity. Ten days old seedlings were treated with 0, 40 and 80 mM NaCl. The growth and physiological data were recorded at different time intervals. Plants were harvested at 6 days after salinity (DAS) for measuring root-shoot dry biomass. Powdered root and shoot tissues were digested overnight with 1M HNO₃ at 80°C and cation analysis was carried out by Ion Chromatography (Dionex DX500 System). Data were analysed using Minitab (v15) and SAS (v9.1.3) programs.

**Results**

The response of rice genotypes to different salt level and their interaction showed significant variation in terms of different growth and physiological parameters (Table 1).
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Table 1: Mean squares and F-tests of main effects and interactions for growth and physiological characters under salt stress

<table>
<thead>
<tr>
<th>Source (df)</th>
<th>LER</th>
<th>RER</th>
<th>SES (6DAS)</th>
<th>Root dry wt. x 10^-5</th>
<th>Shoot dry wt. x 10^-4</th>
<th>LA x 10^3</th>
<th>Transpiration rate</th>
<th>LRS-2DAS</th>
<th>Shoot Na x 10^2</th>
<th>Shoot K x 10^2</th>
<th>Shoot Na/K</th>
</tr>
</thead>
<tbody>
<tr>
<td>G (7)</td>
<td>0.51**</td>
<td>0.24**</td>
<td>16.60**</td>
<td>5.99**</td>
<td>20.87**</td>
<td>68.33**</td>
<td>2.28**</td>
<td>3.65**</td>
<td>33.98**</td>
<td>25.77**</td>
<td>1.18**</td>
</tr>
<tr>
<td>T (2)</td>
<td>1.53**</td>
<td>3.47**</td>
<td>247.39**</td>
<td>53.36**</td>
<td>113.97**</td>
<td>493.65**</td>
<td>24.01**</td>
<td>71.43**</td>
<td>404.22**</td>
<td>6.13**</td>
<td>10.32**</td>
</tr>
<tr>
<td>GxT (14)</td>
<td>0.11**</td>
<td>0.09**</td>
<td>5.87**</td>
<td>2.32**</td>
<td>3.03**</td>
<td>6.93**</td>
<td>0.57**</td>
<td>1.19**</td>
<td>13.14**</td>
<td>9.57**</td>
<td>0.37**</td>
</tr>
</tbody>
</table>

G. genotype and T. treatment

At 80mM NaCl, the co-efficient of shoot elongation-CSE (Devitt 1984) was the highest in Pokkali followed by Banikat and the lowest in *O. rupipogon*, however at 40 mM NaCl PSBRc50 showed the highest value (Table 2). The genotypes Pokkali followed by PSBRc50 and Banikat were the most salt tolerant genotypes at 6 DAS in terms of standard evaluation score (Gregorio 1997) at both salt levels whereas BRRI dhan 29 and *O. latifolia* were the most susceptible genotypes (Figure 1). Plants became more affected at longer stress duration; however at high salt concentration, the genotypes IR 58, BRRI dhan 29 and *O. latifolia* were affected earlier (e.g., 3 DAS) compared to other genotypes. Interestingly, in case of leaf rolling score at 2 DAS (using a 1 - 5 scale with 1 being the first evidence of rolling and 5 being a closed), susceptible genotype IR58 showed also less rolling at both salt levels compared to the tolerant genotypes Pokkali and PSBRc50 (Table 2). Leaf elongation rate (LER) and Root elongation rate (RER) at 3-6 DAS were severely reduced in highly susceptible genotype BRRI dhan 29 followed by Banikat and Nipponbare at both salt level.
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Figure 1: Standard evaluation score (SES) of 40 and 80 mM NaCl stressed eight genotypes with the progress of stress duration (3, 4, 5 and 6 days after application of salt treatment). Values are means ± SE (n=3). All the genotypes scored ‘0’ at control treatment.

Interestingly, tolerant genotype *O. rupipogon* showed second highest RER at 40 mM NaCl but at 80 mM NaCl treatment root elongation rate was significantly reduced. In general, leaf area (LA) was reduced gradually with the increase in salt level in all the genotypes; however transpiration rate (RT) did not show large variation, both data were recorded at 5 DAS. Seedling height, root length and root and shoot weight were analysed as percent change compared to control plants. Reduction in seedling height was the lowest in Pokkali followed by Banikat and the highest in BRRI dhan 29 and *O. Latifolia* at both salt levels. Interestingly, the highly susceptible genotype *O. latifolia* and Nipponbare showed significant increase in root length at low salt level, which however declined at high salt level while *O. latifolia* maintained more root length than the control seedling at both salt levels.
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Table 2: Changes in physiological parameters of rice seedlings due to salt stress (values are expressed as a percentage of control except for CSE, SES and LRS)

<table>
<thead>
<tr>
<th>Genotype &amp; Salt level (mM NaCl)</th>
<th>CSE</th>
<th>SES*</th>
<th>LER*</th>
<th>RER- (mm/d)</th>
<th>LA (cm²)</th>
<th>TR- (g/gDW/h)</th>
<th>% control (6 DAS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Plant height</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Root length</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shoot wt.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Root Wt.</td>
</tr>
<tr>
<td>Pokkali 40</td>
<td>58.0</td>
<td>1.7a</td>
<td>2.0a</td>
<td>0.7a</td>
<td>2.8a</td>
<td>124a</td>
<td>99.4a</td>
</tr>
<tr>
<td></td>
<td>46.0</td>
<td>3.0a</td>
<td>2.7a</td>
<td>0.6bc</td>
<td>1.1a</td>
<td>92.4a</td>
<td>88.7a</td>
</tr>
<tr>
<td>PSBRc540 40</td>
<td>74.7</td>
<td>2.3ab</td>
<td>2.3a</td>
<td>1.2ab</td>
<td>1.2c</td>
<td>120ab</td>
<td>79.1b</td>
</tr>
<tr>
<td></td>
<td>2.2c</td>
<td>5.0b</td>
<td>4.3a</td>
<td>1.1ab</td>
<td>1.3a</td>
<td>56.3bc</td>
<td>55.7cd</td>
</tr>
<tr>
<td>IR58 40</td>
<td>35.9</td>
<td>5.0d</td>
<td>2.7a</td>
<td>1.8a</td>
<td>1.1c</td>
<td>105bc</td>
<td>68.03b</td>
</tr>
<tr>
<td></td>
<td>1.2c</td>
<td>7.7d</td>
<td>3.7a</td>
<td>1.3a</td>
<td>0.2b</td>
<td>50.0d</td>
<td>63.6bc</td>
</tr>
<tr>
<td>BRRI dhan 29</td>
<td>2.3c</td>
<td>7.7c</td>
<td>5.0d</td>
<td>0.2c</td>
<td>0.1c</td>
<td>24.4d</td>
<td>55.3cd</td>
</tr>
<tr>
<td>Banikat 40</td>
<td>58.3</td>
<td>3.7bc</td>
<td>3.3ab</td>
<td>0.4bc</td>
<td>1.3c</td>
<td>101bc</td>
<td>77.2b</td>
</tr>
<tr>
<td></td>
<td>23.1</td>
<td>7.7c</td>
<td>4.0b</td>
<td>0.2c</td>
<td>0.1b</td>
<td>64.4bc</td>
<td>69.6b</td>
</tr>
<tr>
<td>Nipponbare 40</td>
<td>66.8</td>
<td>3.7c</td>
<td>4.7b</td>
<td>0.4bc</td>
<td>2.0b</td>
<td>71.1d</td>
<td>76.9b</td>
</tr>
<tr>
<td></td>
<td>0.9c</td>
<td>9.0d</td>
<td>5.0b</td>
<td>0.1c</td>
<td>0.6b</td>
<td>8.0d</td>
<td>55.2cd</td>
</tr>
<tr>
<td>O. latifolia 40</td>
<td>23.8</td>
<td>7.0c</td>
<td>4.7b</td>
<td>0.8bc</td>
<td>1.9b</td>
<td>65.9d</td>
<td>58.8b</td>
</tr>
<tr>
<td></td>
<td>2.0c</td>
<td>9.0d</td>
<td>5.0b</td>
<td>0.3c</td>
<td>0.6b</td>
<td>23.3d</td>
<td>44.3d</td>
</tr>
<tr>
<td>O. rupipogon 40</td>
<td>30.7</td>
<td>4.3c</td>
<td>3.7bc</td>
<td>1.8a</td>
<td>2.4ab</td>
<td>54.3b</td>
<td>57.7b</td>
</tr>
<tr>
<td></td>
<td>0.0c</td>
<td>9.0d</td>
<td>4.7ab</td>
<td>0.4c</td>
<td>0.2a</td>
<td>32.6bc</td>
<td>46.2d</td>
</tr>
</tbody>
</table>

*Values followed by a common letter in a column are not significantly different at the 0.05 probability as determined by the Duncun’s multiple range test.
*All genotypes at control treatment scored 1 and 0 for SES and LRS, respectively.
Mohammed Rashed Hossain

Meeting the challenge of growing rice in saline areas through physiological
and omics technologies
Shoot Na\(^+\):K\(^+\) ratio was similar for all the genotypes in the absence of salt but increased significantly at elevated salt levels in all the genotypes except Pokkali, consistent with a high tolerance to salt in this genotype (Figure 2). The data indicates that the addition of salt causes selective uptake of Na\(^+\) by plants over the K\(^+\) ion and tolerant genotypes posses the ability to maintain the balance of cation uptake. The ratio also increased significantly from low to high salt level; however IR58 and BRRI dhan 29 reached at maximum uptake at low salt levels which showed no significant increase at high salt level, consistent with an inability to exclude toxic Na\(^+\) ions even at low salt level.

Cluster analysis based on all measured parameters separated the genotypes in three distinct groups (Figure 3) viz., highly tolerant (Pokkali), moderately tolerant (PSBRc50, Banikat and O. rupipogon) and susceptible (O. latifoila, IR 58, BRRI dhan 29 and Nipponbare).

![Figure 2: Ratio of Na and K ion concentrations in shoots of 0, 40 and 80 mM NaCl stressed rice seedlings at 6 DAS. Values are means ± SE (n=3). *, ** and *** indicate significant at p<0.05, P<0.01 and p<0.001 by student’s t-test when compared to control seedlings.](image-url)
Figure 3: Cluster analysis based on the growth and physiological parameters separated eight genotypes into three distinct groups viz., highly tolerant, moderately tolerant and susceptible. The three rice plants (L-R) of each genotype represent plants stressed with 0, 40 & 80 mM NaCl.

The next step of the project will be transcriptomics analysis of these genotypes that vary in salt tolerance. The physiological data described above will be used to interrogate this data set to identify those genes that have a role in tolerance to salt. These data will broaden our understanding of the mechanism of salt tolerance in rice and suggest candidate genes that can be used in GM or conventional breeding programmes.

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A novel protein enrichment system consisting of dual-stage osmosis (forward osmosis, FO) processes was conceptually demonstrated. FO is recognized as the future technology in food production, such as juice or protein solution enrichment. FO is conducted without heat or pressure and no chemicals are involved, thus the important ingredients in food can be well preserved. Through the dual-stage FO system, proteins can be effectively enriched without structural changes. In the up-stage system, protein solution was enriched by a concentrated nanoparticle solution, partitioned by a semi-permeable membrane; similarly, the diluted nanoparticle solution was enriched by reverse osmosis retentate solution in down-stage system. The dual-stage FO system exhibit superiorities than other protein enrichment processes in terms of protein quality and production cost.

Introduction
Proteins, as the most important biopolymer in nature, have a wide range of commercial applications in nutraceutical, medical and pharmaceutical markets. The production of proteins with high resolution and high productivity has been considered as technically and economically challenging (Gosh, 2003). In protein production, the process of protein enrichment plays an important role and is accompanied with protein separations. Most proteins are labile and heat sensitive, athermal separations are preferred. Organic solvents are usually used to crystallize proteins in production, which may affect the food safety of protein for intake. Therefore, searching for innovative athermal enrichment processes without chemicals involved provides strong incentives for protein industries because not only can it lower the production cost but also protect protein quality as well as food security.
Forward Osmosis (FO), as an emerging technology to alleviate global water shortage in the coming decennia, is now intensely studied by researchers (Chung, 2011). In FO, the osmotic pressure difference across the semi-permeable membrane acts as the driving force to extract water from the solution of the higher chemical potential to the lower, which is molecularly triggered without any external help. Traditionally, a hydraulic pressure is necessarily applied in nearly all other membrane processes to force water and other permeates through the membrane. Comparing to pressure-driven membrane separation processes, FO is unique by utilizing osmotic pressure gradients as the driving force with potentially lower energy consumption and less membrane fouling propensity, which makes the osmotically driven FO process more economically favourable.

In this report, we aim to demonstrate, for the first time, a self-sustainable dual-stage FO system for protein enrichment using (1) highly hydrophilic nanoparticles as draw solute to concentrate protein solutions in the up-stage FO, and (2) reverse osmosis (RO) retentate of RO plants as the draw solute to re-concentrate nanoparticle solutions in the down-stage FO, operated in a continuous mode as shown in Figure 1. Highly hydrophilic nanoparticles capped with polyacrylic acid (PAA-NPs) were chosen as draw solutes in this work because of their high osmotic pressure; moreover, their reverse flux (i.e., back diffusion to the protein solution) is minimal as they are too large to pass FO membrane pores (Ling, 2010) compared to chemical compound, such as inorganic salt. Protein molecules are sensitive to ionic strengths in solutions. Their conformation and stability could be influenced thereby (Dominy, 2002). Hence, using nanoparticles rather than salts as draw solute can greatly lower the risk of denaturing proteins during the enrichment process. In the down-stage FO, RO retentate solution was employed to regenerate hydrophilic nanoparticle solution because the sodium chloride retentate emitted from RO plants possesses extremely high osmotic pressures. Besides, it would be a waste if it is discharged.
Results and discussion

Protein enrichment process through dual-FO system was carried out on a lab-scale circulating filtration unit as shown in Figure 1. An ultraviolet (UV) visible spectrophotometer (BIOCHROM LIBRA S32) with a kinetic function was introduced to indicate the protein enrichment trend. Bovine Serum Album (BSA) was used as model protein in this study. Circular Dichroism (CD) measurements were conducted to detect protein structural changes during the process. CD spectra reveal that the structure of BSA enriched by the RO retentate has been significantly changed because its mean molar ellipticity shows a considerable detour compared to original BSA. In the contrary, for BSA concentrated by the PAA-NPs solution in both

Figure 1: Schematic diagram of the laboratory-scale dual FO system for protein enrichment
single and dual-stage FO, no obvious changes were observed, which confirmed that the BSA structures have been well preserved. Lysozyme (LYZ) and Soybean Trypsin Inhibitor (STI) were also tested in dual-FO system to investigate the protein size and charge effects. It is found that protein of larger size and opposite charge to the membrane surface exhibit higher enrichment efficiency. By engineering operational parameters of dual-FO system, such as increasing membrane surface area, osmotic pressure of draw solution and the operation duration, protein enrichment efficiency can be easily doubled. Choice of membrane orientations of least concentration polarization and fouling phenomenon can result in the best enrichment performance through dual-FO system.

Conclusion
We have demonstrated dual-stage FO systems, for the first time, for protein enrichment using nanoparticles as intermediate draw solutes. The newly developed system can be applicable to various proteins of different sizes and charges. The dual-stage FO system consisting of a large membrane surface and highly osmotic draw solutes can effectively dehydrate protein solutions under athermal conditions. It is believed that the dual-stage FO system has great potential in future applications of protein and pharmaceutical enrichments because of its simplicity, practicality, and economy.

Reference
Gosh, R 2003, Protein Bioseparation Using Ultrafiltration: Theory, Applications and New Developments. Imperial College Press, UK


Novel dual-stage FO system for sustainable protein enrichment using nanoparticles as intermediate draw solute

How can synthetic fertiliser be included in sustainable agriculture?

Luisa Margiotta
University of Edinburgh

Introduction
With over one billion people already suffering from malnutrition, the sustainability of food production has become a top priority. Indeed, the looming obstacles of both climate change and a rising global population necessitate an agricultural system which takes account for productivity whilst minimizing the impacts on the environment (Mäder et al, 2002). More specifically, this implies commitment in conserving resources and minimizing environmental disturbance whilst still respecting economic and societal goals. This is no easy task: with the increasing use and dependency on synthetic nitrogen (N) fertilisers, the future challenge in agriculture is how to integrate fertiliser usage into sustainable agriculture.

Fertiliser dependence
As figure 1 demonstrates, trends in fertiliser use and crop production are proportionally related. After World War II, the technological innovation of the Haber-Bosch process facilitated biologically-available nitrogen became abundant in its application to crops in the form of synthetic nitrogen (N) fertiliser, which allowed for a comparable increase in crop growing capacities (Galloway & Cowling, 2002). At present, approximately 40% of the world’s dietary protein can be attributed to N fertiliser with two billion people worldwide dependent on it to attain their food supply. Stewart et al (2005) credits commercial fertiliser as a crucial component of 30 - 50% of all crop yields.
How can synthetic fertiliser be included in sustainable agriculture?

**Figure 1: World cereal and fertiliser production from 1961 – 2008 (Source: FAOSTAT, 2008)**

**Fertiliser implications**

Despite the success achieved by synthetic fertilisers, in terms of increased yields, several issues have been raised regarding long term environmental implications. These include eutrophication and anoxic conditions in large bodies of water, stratosphere ozone depletion, troposphere ozone creation, nitrate water contamination, acidification of surface waters, and an increase in anthropogenic greenhouse gas (GHG) emissions (Galloway & Cowling, 2002). Nitrous oxide ($N_2O$) accounts for 8% of global GHGs (Rees & Ball, 2010); a figure which is primarily attributed to arable crop production (Kindred et al, 2008). $N_2O$ is the most damaging agricultural-related GHG as it is 298 times more potent than carbon dioxide (Rees & Ball, 2010) and because its surface emissions have increased by 40-50% from pre-industrial levels (Synder et al, 2009). Furthermore, this gas induces climate change which is set to further alter global crop production patterns, create unpredictable growing seasons for farmers and enhance the risk of
invasive pests and diseases (FAO, 2007). Excessive use of these fertilisers also causes the soil fertility to decrease, creating future ramifications for the future productivity of arable soils (Vasilikiotis, 2000). In short, our dependency on fertiliser has generated global concerns over the prospect of sustainable food production. Despite this, the Millennium Project and its State of the Future (2008) report declared that food production will need to double by 2050 in order to sustain the growing global population (Glenn et al, 2008). Is it possible for 9 billion people to survive in a world without synthetic nitrogen fertilisers?

Currently there is a trade-off between supplying adequate yields and environmental preservation, with an argument that the world food requirements cannot be sustained without nutrient enriched fertilisers, especially in arable regions where soils tend to be nutrient-deficient. Therefore, a key question remains: how can production be maximised whilst also minimizing the damage resulting from fertilisers by adhering to Best Management Practises (BMP)?

**Best Management Practises**

Roberts (2009) argues that production intensification with a strong environmental and ecological focus is the only solution to the global food crisis. Through efficient crop, soil and fertiliser management, nutrient uptake and associated yields can be maximised with less GHG emissions (Synder et al, 2007). Robertson (2007) proposes a popular fertiliser application principal of ‘the right product, right rate, right time and right place,’ which considers each crop species’ specific nutrient requirements to achieve optimal yields. N is most often lost to the environment when mineral nitrogen (NO₃⁻ and NH₄⁺) is applied in excessive quantities (Raun et al, 2002). On average, only 50% of the nitrogen supplied to arable lands is taken up by the plants, hence the remaining 50% either leaches into ground or surface waters or is emitted as N₂O (Galloway & Cowling, 2002). Robertson’s procedure ensures that no unnecessary fertiliser is applied, reducing the adverse effects fertiliser has on the environment.
The data related to the cause and rate of N$_2$O emissions from crops is still incomplete and needs further investigation. Many studies use the standard IPCC (2006) methodology for calculating N$_2$O emissions from farmland (i.e. 1% of N$_2$O emitted for each unit of N fertiliser input); this is a simplistic generalisation between crop management and resultant emissions that does not consider spatial or temporal variations in climate or soil conditions (Rees & Ball, 2010). Therefore, it is crucial that further research focuses on the explicit factors that cause N$_2$O release in local arable systems so that site-specific BMP can be adopted and scaled up.

**Methodology**

The aim of my research is to evaluate the relationship between N input from synthetic fertiliser and the resultant N$_2$O emissions. The experiment involves measuring N$_2$O gas fluxes from three popular British arable crops: Winter Wheat, Oil Seed Rape and Spring Barley from late April through to early/ mid-July 2011. During the growing period of the crops, five different fertiliser concentrations (treatments) will be applied to each crop. Over the course of the project there will be three fertiliser applications of each treatment. Gas samples from the soil will be taken using static manual chambers to determine the N$_2$O concentrations at various stages of the crop life-cycle and under variable weather conditions. In addition to these gas samples, ambient air samples will be taken for a relative comparison, as well as soil samples, to determine the moisture content and the level of nutrients (nitrate and ammonium). Meteorological data will also be recorded throughout the data collection period to use alongside the primary data. There is a meteorological station on site that will be recording air and soil temperature, rainfall and soil moisture.

Once all the data has been collected and processed, statistical analysis will be conducted to find any distinctive trends and/ or relationships between N$_2$O fluxes and all the potential influencing variables, which include: fertiliser concentration, fertiliser application number, crop type, and soil and weather conditions.
Predicted results and future research

There are many factors that influence the rate and extent of N₂O emissions from arable soils, yet it is still possible to predict what conditions will generate higher emissions. In terms of fertiliser treatment, N₂O emissions will most likely continue to increase with increasing fertiliser concentrations; the emissions may also increase with each additional fertiliser application. The climatic factors to induce emissions are likely to be rainfall and temperature. N₂O emissions always peak immediately after fertiliser application but the emission magnitude is strongly linked with soil wetness and texture (Rees & Ball, 2010). It is predicted that following high rainfall events, the emissions from the crops will be higher. Similarly, during periods of elevated temperature, the emissions may also be greater.

There is great potential to extent this research further by comparing the greenhouse gas analysis with the harvest yields (after the project has concluded) to determine the economic and environmental balance between appropriate fertiliser input and cereal output yields. This data could be used to create a more detailed, site-specific fertiliser emission factor for N₂O emissions than the IPCC’s approach; this could be ultimately used in obtaining appropriate GHG mitigation strategies on local and regional scales.

Future of agriculture

Despite the uncertainty and controversies that lie within the agricultural sector, a general consensus has been reached within the scientific community over the objectives of future agriculture (Cassman et al, 2002):

i. Food production must increase to meet the future demands of the growing population;

ii. Almost all of this production must take place on already existing arable land (so not to induce land-use change by encroaching on marginal or forested land);
iii. The nitrogen uptake efficiency of crops must be improved to maximise yields and prevent losses into the environment.

Conclusion
The use of synthetic N fertiliser has many adverse effects on the environment and climatic system that leads to future uncertainty within agricultural productivity. The world’s dependency on N fertiliser is unsustainable, thus it is critical that fertiliser management practises are improved to reduce excessive losses of N₂O. This can be achieved by studying the individual requirements of local crops to account for spatial and temporal variations in emission driving factors such as climate and soil characteristics. The issue of sustainable food production is becoming increasingly vital; however, sustainable agriculture can be achieved by adopting BMPs in arable systems which will ensure enough food can be provided for the growing population with minimal environmental costs.

References


Luisa Margiotta
How can synthetic fertiliser be included in sustainable agriculture?


Disease Resistance

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New Zealand’s kiwifruit blight

Niha Phukan
University of Auckland

Abstract

*Pseudomonas syringae* is a plant pathogen that affects a wide range of plant species, including the kiwifruit plant. Its mode of infection comprises of degradation of the outer cutin layer by secretion of extracellular enzymes such as cutinase. Using the tomato pathovar, we aim to characterise the cutinase enzyme since penetration through the cutin layer could contribute to the pathogenicity of the disease. *P. syringae* pv tomato possesses a cutinase-like esterase gene which would be used for amplification, cloning and expression as a recombinant protein. Understanding the molecular machinery behind the pathogenicity could aid in the creation of innovative techniques for remediation.

Introduction

A recent outbreak of bacterial canker on kiwifruit was reported in New Zealand. It causes substantial damage to the vines but does not affect humans or animals. The major symptoms include a red-rusty exudation on the trunks and twigs, with longitudinal cracks. Browning of the vascular tissues and reddening of the tissues beneath the lenticels can also be observed. Occurrence of dark brown angular spots with yellow haloes, which later turn brown are also another indication of the disease. In addition, both the affected bark and major portions of the leaves appear shrivelled (Scortichini 1994, p. 1035).

This disease can have potentially serious economic repercussions for the New Zealand kiwifruit industry. At present, the kiwifruit exports contribute more than $1.5 billion (New Zealand Dollars) to the country. Since the outbreak of this blight, countries such as the USA and Australia have banned the import of kiwifruits from New Zealand due to fear of contamination of their own kiwifruit vines.
Mechanism of infection

The causal agent of the kiwifruit blight is the *Pseudomonas syringae* pathovar *actinidiae* (PSA). It is a rod-shaped, Gram negative bacteria and a common plant pathogen that infects a wide variety of plants.

Previous studies have shown that the bacteria can attack the host plant by releasing phaseolotoxins and other effectors in vivo. However, in order to do so, it first has to penetrate the outer protective cutin barrier. Like most plant pathogenic bacteria and fungi, *P. syringae* breaks down the outer cutin layer of the kiwifruit to cause infection.

Cutin is a polymer composed of esterified C₁₆ and C₁₈ hydroxy and epoxy fatty acids (Kolattukudy 1981). To degrade the cutin, it secretes an extracellular enzyme known as cutinase, that catalyses the cleavage of the ester bonds of cutin, thereby releasing the cutin monomers (Fett et al 1992). Cutinases have been found in both bacteria and fungi; however, work done on bacterial cutinase is limited and most of the research has centred on fungal cutinases.

Cutinases are fairly common in Pseudomonads and are believed to be serine-hydrolases with serine as a key catalytic residue, similar to esterases. Cutinase work on the actinomycete, *Thermobifida fusca*, by Chen et al (2008) revealed that the structure of the enzyme consists of an α/β hydrolase fold, which consists of a central β-sheet, surrounded by α-helices on either sides. In addition, it also exhibits the presence of a Ser^{170}-His^{248}-Asp^{216} catalytic triad, where the serine residue is located at a sharp turn, known as the “nucleophile elbow”. The structure also contains an oxyanion hole comprising of the amino acid residues Met^{171} and Tyr^{100}.
Methodology

Due to the unavailability of *P. syringae pv. actinidiae*, we shall be working on another similar strain, *Pseudomonas syringae* pathovar *tomato*, which infects tomato leaves and is characterized by the presence of brown-black specks with yellow chlorotic haloes.
Although this plant pathogen infects passively through wounds, open stomata and broken glandular hairs, active penetration with the aid of hydrolytic enzymes, including cutinase secretion, has been reported (Bashan et al 1985).

In the current study, *P. syringae* pv. *actinidiae* strains were tested for their ability to express cutinase in a standard growth medium as well as in a cutin-containing medium. Secreted proteins were extracted from the supernatant by centrifugation, dialysis and freeze-drying to obtain proteins in a concentrated form. After protein analysis by polyacrylamide gel electrophoresis, the next step would be to fractionate and characterize them and check for cutin hydrolysis. Enzymes with cutinase activity would be further subjected to mass spectrometry peptide sequencing to identify corresponding genes in databases.

As a complementary method, a database search using sequences from *Thermobifida fusca* cutinase revealed a putative secreted cutinase orthologue in the *P. syringae* pv. *tomato* genome (PSPTO_4843; NCBI database). Attempts would be made to amplify, clone and express this gene, or other genes identified from their protein products, as recombinant proteins, which would then be used for further enzymology.

**Conclusion**

It has been suggested that *Pseudomonas syringae* secretes cutinase to break through the cutin polymer layer on the surface of fruits and cause infection. Characterization of the bacterial cutinase could pave the path for development of novel techniques that aim at inhibiting this enzyme, such as specific cutinase inhibitors, thereby reducing the virulence of the pathogen.

**References**


Food security: Analysing levels of resistance of agronomic pest insects to pyrethroid insecticides

Mark Burton
The University of Nottingham & Rothamsted Research

Non-Technical Summary
Research into resistance to pyrethroid insecticides is undertaken at the genetic and molecular level of the insect nervous system. Predicting and controlling resistance involves looking directly at genomic alterations to the pyrethroid target site within pest insects, in this case the voltage-gated sodium channel (VGSC). One specific, common, mutation has arisen in many resistant insect species (L1014F) with variations also occurring. Analysing levels of resistance of these mutations, through exploring VGSC modification by different pyrethroid compounds is essential to improve future insect pest control and crop protection.

Introduction
The long-term use of insecticides, used to control a number of agronomically important pest insect species, is threatened by the evolution of resistance mechanisms reducing the effectiveness of these chemicals. The pyrethroid insecticides, a class of insecticide which make up approximately 17% of the market, are thought to be a safer class of compound due to their synthesis from naturally occurring pyrethrins found in some Chrysanthemum species. Resistance mechanisms to pyrethroid compounds include reduced cuticle penetration, increased excretion, increased metabolic detoxification and alteration of the target site. Target site resistance is a broad term encompassing a number of mutations within the VGSC responsible for knockdown resistance (kdr). Kdr was first recognised in Houseflies (Musca domestica) exposed to DDT (Busvine 1951), a recessive allele conferring cross resistance to the entire class of pyrethroids as well as to DDT. Kdr has now been reported in many important pest species (Table 1). The
original, and most prevalent, mutation associated with \textit{kdr} confers a leucine (L) to phenylalanine (F) substitution at position 1014 of domain II segment 6 (DIIS6) of the VGSC (Soderlund & Knipple 2003; Williamson et al. 1996).

VGSCs are neuronal membrane proteins that allow the passage of sodium ions into neurons for the generation of action potentials. Their activation is only possible following the depolarization of the membrane potential to a threshold value that is almost immediately followed by an inactivation process that prevents ‘overconduction’ (Fig. 1A). The membrane then repolarizes and the VGSC resets itself back to a non-conducting state (deactivation). Pyrethroids exert their toxic effects primarily on the central and peripheral nervous system of insects by interacting with the VGSC, increasing its sensitivity to depolarization and prolonging its conducting state by inhibiting the inactivation and deactivation processes, thereby stabilizing the open state of the channel (Soderlund 2004). Ultimately, this results in a state of abnormal hyperexcitability and the incapacitating, sublethal effect known as ‘knockdown’.

The economic impact of pest insects is around 15% (Oerke et al. 1994), and resistance in insect species further augments and complicates this issue. Here I present electrophysiology and toxicology data exploring three substitutions at the L1014 locus, identified as pyrethroid resistance mutations in a number of pest insect species in context with their prevalence and impact upon agriculture cash crops.
Table 1: List of important agricultural pest insects with resistance mutations at the L1014 locus

<table>
<thead>
<tr>
<th>Name</th>
<th>Common Name</th>
<th>Mutations</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Myzus persicae</em></td>
<td>Peach potato aphid</td>
<td>L1014F</td>
</tr>
<tr>
<td><em>Cydia pomonella</em></td>
<td>Codling moth</td>
<td>L1014F</td>
</tr>
<tr>
<td><em>Haematobia irritans</em></td>
<td>Horn fly</td>
<td>L1014F</td>
</tr>
<tr>
<td><em>Helicoverpa zea</em></td>
<td>Tobacco budworm</td>
<td>L1014H</td>
</tr>
<tr>
<td><em>Leptinotarsa decemlineata</em></td>
<td>Colorado beetle</td>
<td>L1014F</td>
</tr>
<tr>
<td><em>Liriomyza huidobrensis</em></td>
<td>Pea leafminer</td>
<td>L1014F</td>
</tr>
<tr>
<td><em>Liriomyza sativae</em></td>
<td>Vegetable leafminer</td>
<td>L1014F</td>
</tr>
<tr>
<td><em>Liriomyza trifolii</em></td>
<td>Serpentine leafminer</td>
<td>L1014H</td>
</tr>
<tr>
<td><em>Musca domestica</em></td>
<td>House fly</td>
<td>L1014F, L1014H</td>
</tr>
<tr>
<td><em>Plutella xylostella</em></td>
<td>Diamond back moth</td>
<td>L1014F</td>
</tr>
<tr>
<td><em>Frankliniella occidentalis</em></td>
<td>Western Flower Thrip</td>
<td>L1014F</td>
</tr>
<tr>
<td><em>Blatella germanica</em></td>
<td>German Cockroach</td>
<td>L1014F</td>
</tr>
<tr>
<td><em>Anopheles gambiae</em></td>
<td>African malarial mosquito</td>
<td>L1014F, L1014S</td>
</tr>
</tbody>
</table>

Methods

Mutations were inserted into the *Drosophila melanogaster* (*para* 13-5) VGSC gene (Vais et al 2000; Warmke et al 1997) and endogenously expressed with *tipE* in *Xenopus laevis* oocytes. A two electrode voltage clamp technique was employed to manipulate voltage and record current. Depolarizing voltage steps were used to investigate the properties of VGSCs in the absence and presence of pyrethroids.

Results

L1014F and L1014H shifted the $V_{50,act}$ (voltage at which 50% of channels are activated) in the depolarising direction (Fig. 1B, Table 2). L1014S showed no statistical difference in the $V_{50,act}$. The rate of current decay, was explored for each channel. Only the L1014S exhibited a significant and consistent change from the wild-type, whereby it increased the rate of current decay. Data exploring $V_{50,inact}$ (voltage at which 50% of channels are inactivated) for each channel was recorded.
Figure 1: A) Typical family of VGSC current responses to different depolarizing voltage steps. B) Conductance-voltage relationships for wild-type and modified VGSCs. C) Voltage dependence of steady-state inactivation of wild-type and modified VGSCs.
The degree of resistance imparted by each of the substitutions at the L1014 locus was also illustrated by the effect of pyrethroids on ‘tail currents’ that arise by pyrethroid inhibition of deactivation. The order of resistance to deltamethrin-induced tail currents was L1014H>L1014F>L1014S>wild-type with resistance factors (RFs) of 66, 49, 26 and 1 respectively (Fig. 2). The order of resistance to permethrin-induced tail currents was L1014F>L1014S>L1014H>wild-type with RFs of 259, 47, 13 and 1 respectively (Fig. 3).
Table 2: The effects of increasing concentrations of insecticide on the properties of wild-type and L1014 modified VGSCs.

<table>
<thead>
<tr>
<th>Insecticide Concentration</th>
<th>Wild-type</th>
<th>L1014F</th>
<th>L1014S</th>
<th>L1014H</th>
</tr>
</thead>
<tbody>
<tr>
<td>No insecticide</td>
<td>V_{10,act} (mV)</td>
<td>-17.3 ± 0.4 (16)</td>
<td>-13.1 ± 0.8 (10)**</td>
<td>-18.3 ± 0.5 (8)</td>
</tr>
<tr>
<td></td>
<td>V_{10,linact} (mV)</td>
<td>-47.0 ± 0.3 (11)</td>
<td>-43.2 ± 0.4 (13)**</td>
<td>-42.4 ± 0.5 (12)**</td>
</tr>
<tr>
<td>1 nM</td>
<td>V_{10,act} (mV)</td>
<td>-21.7 ± 0.6 (7)**</td>
<td>-15.0 ± 0.7 (5)**</td>
<td>-19.3 ± 0.4 (13)**</td>
</tr>
<tr>
<td></td>
<td>V_{10,linact} (mV)</td>
<td>-45.2 ± 0.3 (6)**</td>
<td>-42.4 ± 0.4 (7)**</td>
<td>-43.8 ± 1.4 (10)**</td>
</tr>
<tr>
<td>5 nM</td>
<td>V_{10,act} (mV)</td>
<td>-22.4 ± 0.4 (10)**</td>
<td>-14.3 ± 0.9 (3)**</td>
<td>-19.3 ± 0.7 (9)**</td>
</tr>
<tr>
<td></td>
<td>V_{10,linact} (mV)</td>
<td>-44.1 ± 0.2 (6)**</td>
<td>-43.7 ± 0.7 (6)**</td>
<td>-42.2 ± 0.3 (8)**</td>
</tr>
<tr>
<td>30 nM</td>
<td>V_{10,act} (mV)</td>
<td>-24.2 ± 0.4 (7)**</td>
<td>-16.6 ± 0.8 (4)**</td>
<td>-21.9 ± 0.4 (3)**</td>
</tr>
<tr>
<td></td>
<td>V_{10,linact} (mV)</td>
<td>-42.4 ± 0.3 (3)**</td>
<td>-43.5 ± 0.6 (6)**</td>
<td>-41.5 ± 0.2 (9)**</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Insecticide Concentration</th>
<th>EC_{50} (nM)</th>
<th>M_{max} (%K)</th>
<th>RF = 1</th>
<th>RF = 4S</th>
<th>RF = 26</th>
<th>RF = 66</th>
</tr>
</thead>
<tbody>
<tr>
<td>No insecticide</td>
<td>43 (10)</td>
<td>837 (10)</td>
<td>210 (10)</td>
<td>588 (9)</td>
<td>1249 (9)</td>
<td>370 (9)</td>
</tr>
<tr>
<td>1 nM</td>
<td>17.5 ± 0.3 (4)</td>
<td>-11.1 ± 0.7 (9)**</td>
<td>-18.7 ± 5.8 (15)</td>
<td>-18.1 ± 0.9 (5)**</td>
<td>-18.0 ± 0.9 (5)**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>47.2 ± 0.2 (4)</td>
<td>-44.3 ± 0.6 (8)**</td>
<td>-44.1 ± 0.7 (8)**</td>
<td>-43.2 ± 0.9 (3)**</td>
<td>-43.2 ± 0.9 (3)**</td>
<td></td>
</tr>
<tr>
<td>5 nM</td>
<td>16.6 ± 0.4 (5)</td>
<td>-12.8 ± 0.8 (6)**</td>
<td>-18.7 ± 0.8 (9)</td>
<td>-22.1 ± 0.6 (5)**</td>
<td>-24.9 ± 0.8 (4)**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>46.6 ± 0.2 (5)</td>
<td>-43.2 ± 0.7 (8)**</td>
<td>-42.9 ± 0.6 (10)**</td>
<td>-43.2 ± 0.5 (3)**</td>
<td>-43.2 ± 0.5 (3)**</td>
<td></td>
</tr>
<tr>
<td>30 nM</td>
<td>21.3 ± 0.3 (5)**</td>
<td>-14.6 ± 0.6 (8)**</td>
<td>-22.4 ± 0.6 (7)**</td>
<td>-24.9 ± 0.8 (4)**</td>
<td>-24.9 ± 0.8 (4)**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>45.6 ± 0.3 (3)*</td>
<td>-44.6 ± 0.5 (8)**</td>
<td>-42.6 ± 0.6 (12)**</td>
<td>-42.5 ± 0.6 (3)**</td>
<td>-42.5 ± 0.6 (3)**</td>
<td></td>
</tr>
</tbody>
</table>

*Statistical comparisons were drawn for V_{10,linact} between the wild-type channel without insecticide and channels modified by increasing concentrations of insecticides (**) and between individual channels without and with specific concentrations of insecticide (**) by unpaired Student t test.*
Mark Burton
Food security: Analysing levels of resistance of agronomic pest insects to pyrethroid insecticides
Figure 2: Analysis of channel sensitivity to deltamethrin through analysis of tail current amplitude ($M$) or combined amplitude and duration ($M_T$) (concentrations of deltamethrin are in nanomolar).
Figure 3: Analysis of channel sensitivity to permethrin through analysis of tail current amplitude (M) or combined amplitude and duration (M₅) (concentrations of permethrin are in nanomolar)

Discussion and conclusions
The L1014 locus of the para VGSC of D. melanogaster has been identified as a primary site conferring kdr (L1014F) in a number of pest insect species. Additional Serine and Histidine mutations have also arisen questioning how resistance is established through these mutations. The mechanism by which L1014F resistance occurs is undoubtedly complicated and difficult to define (O’Reilly et al 2006) but resistance must manifest through either: 1. alteration of channel kinetics such that pyrethroids have reduced opportunity to bind or in such a way as to offset those imposed by pyrethroids; or 2. a conformational change that is responsible for reduced pyrethroid affinity at their binding pocket.

In the present study, orders of resistance to permethrin and deltamethrin are different suggesting different resistance
mechanisms to dissimilar pyrethroids. Channel activation data reveals $V_{50,\text{act}}$ of the L1014F and L1014H channels to be shifted to a more positive potential. The result of this is a less voltage-sensitive channel whereby further depolarisation is required for activation and to elicit an action potential. The ability of L1014F/H modified channels to shift $V_{50,\text{act}}$ to more positive potentials (Fig. 1, Table 2) may enable them to accommodate better the pyrethroid-induced negative shifts in $V_{50,\text{act}}$. Serine, upon substitution at the 1014 locus, shows no significant difference in $V_{50,\text{act}}$ from the wild-type but shows a significantly increased rate of fast inactivation of the channel at all depolarisations tested which may contribute to reducing toxicity of pyrethroid compounds.

In conclusion, our data give additional insight into the complex mechanisms of resistance conferred by mutations at the L1014 site within the VGSC. The finding that $kdr$ mutations, different from the classical L1014F, may have arisen through selection pressure from different pyrethroid insecticides, offers some scope for controlling pests carrying these mutations simply by switching to a different type of pyrethroid. Maintaining the efficacy of pyrethroid compounds, through understanding the physiology of resistance, is paramount in boosting crop yields to reach food production targets.

**Funding**
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**References**


Mark Burton
Food security: Analysing levels of resistance of agronomic pest insects to pyrethroid insecticides


Introduction

Anthracnose caused by the *Colletotrichum* spp. is the most devastating disease which causes damage to plants resulting in decrease of total yield, reducing fruit quality as well as the fruit value. The fungal pathogen not only attacks after harvest but also the live stems, branches, flower buds are also affected (Hoa, 2008).

Dragon fruit is one of the most important tropical fruits of Malaysia. However, its production is limited due to certain factors. Among other factors responsible for limited yield of this fruit pre harvest anthracnose caused by the fungus *Colletotrichum gloeosporioides* is the most prevalent. The farmers lost almost 90% of their normal production that equals to 1.125mt/ha/month worth about RM 3,375/ha/month due to this disease. In year 2008, a total loss of RM 11.2 million has been reported only in Malaysia due to this disease (Cheah & Zulkarnain, 2008).

Synthetic fungicides such as Carbendazim, Propineb and Difenoconazole are commonly used to control dragon fruit plant diseases (Hoa, 2008). However, toxicological effects of fungicide to human health, emergence of resistant strains of fungus and environmental pollution necessitated the development of non-toxic biofungicide (Djioua et al 2010).

Chitosan can be one of the potential antifungal candidate which is obtained from crab and shrimp shells. Several studies have
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reported on the anti microbial activities of chitosan to control pre and postharvest diseases of various fruits and vegetables (Ali et al 2010; Tripathi & Dubey, 2004). However, a potent alternative of using the conventional form of chitosan against C. gloeosporioides, colloidal carriers such as chitosan nanoemulsions will have the intense potential.

Thus, the present study was aimed to evaluate the in vitro efficacy of nanoemulsions encapsulated with chitosan against C. gloeosporioides isolated from dragon fruit plants, with the main emphasis to be used as an alternative green fungicide.

**Material and methods**

**Isolation and inoculum preparation of C. gloeosporioides**
C. gloeosporioides was isolated from infected dragon fruit plants and inoculums were maintained on potato dextrose agar (PDA) plates for further studies.

**Preparation of nanoemulsions encapsulated with chitosan**
Separate solutions of different concentration of chitosan (0.5, 1.0, 1.5, 2.0%) and emulsifiers (Brij 56, Span 20) were prepared and then subjected to ultrasonication using an ultrasound bath to obtain nanoemulsions encapsulated with chitosan at different droplet sizes (200, 400, 600, 800, 1000 nm).

**Antifungal assay of nanoemulsions encapsulated with chitosan**
Antifungal assay of nanoemulsions encapsulated with chitosan was performed based on inhibition in radial mycelial growth of C. gloeosporioides on PDA medium using the poison food technique. The in vitro conidial germination inhibition test was carried out using the cavity slide technique and the percentage inhibition in germination was calculated by the method of Cronin et al (1996). Percentage inhibition in spore viability and dry weight of mycelia were also determined by the methods described by Al-Hetar et al (2010).
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A completely randomized design (CRD) was used with four replications of twenty Petri plates for each treatment. Analysis of variance for the data was performed using MSTAT-C Software and the means were separated according to Least Significant Difference test at \( P < 0.05 \).

**Results and discussion**

The inhibition in radial mycelial growth of *C. gloeosporioides* was dependent on chitosan concentrations and droplet sizes (Table 1). However, the chitosan nanoemulsion at 600 nm droplet size gave minimum radial mycelial growth at 1.0% concentration. On the basis of these results only 1.0% concentration of chitosan was selected with different particle sizes for all other parameters.

**Table 1: Effect of nanoemulsions encapsulated with chitosan at different droplet sizes and chitosan concentrations on radial mycelial growth of *C. gloeosporioides***

<table>
<thead>
<tr>
<th>Chitosan Concentration</th>
<th>200</th>
<th>400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>7.50a</td>
<td>7.50a</td>
<td>7.50a</td>
<td>7.50a</td>
<td>7.50a</td>
</tr>
<tr>
<td>0.5%</td>
<td>5.46b</td>
<td>4.04c</td>
<td>3.84d</td>
<td>3.95d</td>
<td>3.99d</td>
</tr>
<tr>
<td>1.0%</td>
<td>3.89d</td>
<td>3.24e</td>
<td>0.98g</td>
<td>1.24f</td>
<td>1.31f</td>
</tr>
<tr>
<td>1.5%</td>
<td>1.24f</td>
<td>1.19f</td>
<td>0.76g</td>
<td>0.84g</td>
<td>0.89g</td>
</tr>
<tr>
<td>2.0%</td>
<td>1.02f</td>
<td>1.10f</td>
<td>0.73g</td>
<td>0.82g</td>
<td>0.88g</td>
</tr>
</tbody>
</table>

The data were recorded after 10 days of incubation at 25°C. Different letters denote a significant difference \( P < 0.05 \) by LSD test.
The nanoemulsion encapsulated with chitosan at 600 nm droplet size gave 93.1% inhibition in conidial germination at 1.0% concentration (Table 2). The similar results were obtained for percentage inhibition in spore viability and dry weight of mycelia.

In previous studies, it has been proved that chitosan at different concentrations (0.01-1%) markedly inhibited mycelial growth of *Botrytis cinerea* and *Penicillium expansum* (Liu et al 2007). Similarly, in a recent study by Al-Hetar et al (2010), it was observed that chitosan markedly inhibited the conidial germination after using chitosan. However, in the present study, chitosan in the form of nanoemulsions added to growth media showed the greatest effect against *C. gloeosporioides* the causal agent of anthracnose in dragon fruit plants.

**Table 2: Effect of nanoemulsions encapsulated with chitosan at different droplet sizes and 1.0% chitosan concentration on conidial germination inhibition, spore viability inhibition and dry weight of mycelia of *C. gloeosporioides***

<table>
<thead>
<tr>
<th>Droplet Size (nm)</th>
<th>Conidial germination inhibition (%)</th>
<th>Spore viability inhibition (%)</th>
<th>Dry weight of Mycelia (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.0 d</td>
<td>0.0 d</td>
<td>1.33 a</td>
</tr>
<tr>
<td>200</td>
<td>62.1 c</td>
<td>62.4 c</td>
<td>0.81 b</td>
</tr>
<tr>
<td>400</td>
<td>68.9 b</td>
<td>68.7 b</td>
<td>0.73 c</td>
</tr>
<tr>
<td>600</td>
<td>93.1 a</td>
<td>92.5 a</td>
<td>0.47 d</td>
</tr>
<tr>
<td>800</td>
<td>92.4 a</td>
<td>91.6 a</td>
<td>0.49 d</td>
</tr>
<tr>
<td>1000</td>
<td>91.6 a</td>
<td>90.7 a</td>
<td>0.52 d</td>
</tr>
</tbody>
</table>

*Different letters in columns denote a significant difference (P < 0.05) by LSD test.*

Thus, it can be concluded from the present investigation that chitosan in the form of nanoemulsions has better potential to be considered as a suitable alternative to synthetic fungicides for controlling anthracnose of dragon fruit plants, which is also non-
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toxic, environment friendly and biodegradable. The most important feature is that it is prepared from sea food industry.

References


Exploring pseudomonad bacteriocins: Highly specific protein antibiotics, as a means of creating disease resistant transgenic plants

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University of Glasgow

Abstract

*Pseudomonas syringae* is a highly economically important, globally distributed plant pathogen. Different pathovars are known to infect over 50 plant species, including tomato, rice and beans with varying symptoms of disease. In many cases effective means of control for this species do not exist leading to significant crop losses (Almeida et al 2009). In this study we have identified genes coding for bacteriocins (protein based antimicrobials) in available genome sequences of a number of *P. syringae* pathovars. Some of these genes have been cloned and expressed using the Polymerase Chain Reaction (PCR) or *in-vitro* DNA synthesis and recombinantly expressed in *Escherichia coli* and *Nicotiana benthamiana*. Bacteriocin protein from this expression was screened for antimicrobial activity against *P. syringae* pathovars firstly to validate the activity and range of these predicted bacteriocins and secondly the production of active protein in a plant system. Results of this study have yielded two new bacteriocins named Syringacin M and L1, potential targets for the creation of transgenic plants.

Introduction

Plant diseases cause annual worldwide crop losses valued at over £100 billion, a situation that is likely to be exacerbated as environmental change facilitates the establishment of new pathogens in previously unfavourable geographical areas (Strange 2005). The aim of this study was to validate bacteriocins as targets for generating transgenic plants that are resistant to bacterial plant pathogens.

In order to control their environmental niche or to gain a competitive advantage, bacteria and other microorganisms produce a vast number of chemical substances which kill or directly
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affect the growth of other microorganisms. These compounds differ widely in function and mode of action, from the small molecule antibiotics which have revolutionised the treatment of infectious disease, to large proteins or protein complexes known as the ‘bacteriocins’ which enzymatically or mechanically disrupt their target cell (Riley & Wertz 2002). While small molecule antibiotics tend to be broad spectrum and are created via a metabolic pathway coded for by a number of genes, bacteriocins are generally genetically simple (with one or two genetic determinants), narrow spectrum, and highly potent. These properties make attractive targets for creating disease resistant transgenic plants (Holtsmark et al 2007).

A model system utilizing P. syringae was chosen for this study as it is a relatively well characterized bacterial species for which some genome sequences are available, as well as a globally important plant pathogen of a large number of species (Almeida et al 2009). As a result, this study while determining general targets and methods for the creation of disease resistant transgenics, aimed to identify methods and bacteriocins directly useful for generating plants resistant to P. syringae.

Methods and results:
The protein sequences from number bacteriocins previously characterized in the literature, namely the pyocins of Pseudomonas aeruginosa and colicins of Escherichia coli, were used to interrogate the GENBANK genome derived, protein database for P. syringae strains, using the BLAST program of the NCBI website. The results of this search are presented in Table 1.

The genes corresponding to proteins NP_790419, ZP_07263221 and Putidacin L1 were cloned using PCR or synthesized externally. These genes were incorporated into E. coli expression vectors and Agrobacterium tumefaciens based binary vectors using standard techniques from Sambrook et al 2001.
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*E. coli* expression vectors were used to transform an appropriate *E. coli* expression cell line for testing antimicrobial activity. Solid agar and liquid grown cell extracts from these cells lines were tested for antimicrobial activity by spotting onto growth agar seeded with 11 *P. syringae* pathovars isolated from various host plants. NP_790419 (named Syringacin M) was found to inhibit the growth of two of 11 strains, while ZP_07263221 (Syringacin L1) and Putidacin L1 inhibited 5 strain each with an overlapping spectrum of activity. The specific nature of this inhibitory activity was confirmed by spotting extracts from the *E. coli* cell line not expressing any additional proteins, these extracts yielded no inhibition. An example of the growth inhibition produced by this experiment is presented in Figure 1.

*A. tumefaciens* transformed with a Syringacin M containing binary vector system was utilised, via leaf infiltration, in transient expression experiments in Nicotiana benthamiana. The bacteriocin sequence was fused to green fluorescent and Myc protein tags to facilitate detection and correct expression in the plant system. Initially expression Syringacin M+GFP was confirmed using confocal microscopy (Figure 2) this experiment showed high levels this protein present in both mesophyll and epidermal cells in transformed leaf sections. Leaf sections transformed with Syringacin M+Myc were snap frozen, ground with extraction buffer and centrifuged. The resulting supernatant containing soluble cellular protein was tested for antimicrobial activity as above. This supernatant was shown to inhibit the same strains as Syringacin M in the *E. coli* system. Leaf extract from un-treated leaves and leaves treated with A. tumefaciens not containing a binary vector showed no activity. Anti-Myc western blot analysis of these extracts confirmed the presence of a protein of the expected size in the Syringacin M+Myc cell extract.

**Conclusions and future directions:**
This study has succeeded in indentifying two novel antimicrobial proteins, Syringacins M and L1 in *P. syringae*. It has shown that these compounds and Putidacin L1 are active against a number of
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*P. syringae* isolates when produced recombinantly in E. coli. It has shown that Syringacin M is active when produced in *N. benthamiana* via Agrobacterium mediated transient expression. These results provide solid proof of concept for the creation of transgenic plants using these proteins and other proteins of the same class.

Future work will be aimed at developing this proof of concept into a model system in which stable bacteriocin expression in a model plant, reduces or eliminates a disease phenotype when it is challenged by a strain of *P. syringae* to which it is susceptible. Once this further proof concept has been achieved, the bacteriocins will be characterised biochemically and manipulated to maximise their spectrum within *P. syringae*. Stable transgenic crops with robust disease resistance will then generated for field trials.

As illustrated by Table 1 there are a considerable number of genes coding for putative bacteriocins still to be investigated in *P. syringae* genomes, in subsequent studies these will be cloned and screened for activity.
### Table 1: Putative Bacteriocins identified in sequenced genomes of *P. syringae* strains. Proteins in bold were chosen for cloning and expression

<table>
<thead>
<tr>
<th>Genbank Accession #</th>
<th>Genome Sequence Pathovar</th>
<th>Predicted Activity Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP_790419</td>
<td>Pseudomonas syringae pv. tomato str. DC3000</td>
<td>Colicin M Type</td>
</tr>
<tr>
<td>NP_794963</td>
<td>Pseudomonas syringae pv. tomato str. DC3000</td>
<td>H-N-H Nuclease</td>
</tr>
<tr>
<td>NP_0790871</td>
<td>Pseudomonas syringae pv. tomato str. DC3000</td>
<td>Carocin D type Nuclease</td>
</tr>
<tr>
<td>ZP_03399950</td>
<td>Pseudomonas syringae pv. tomato T1</td>
<td>H-N-H Nuclease</td>
</tr>
<tr>
<td>ZP_033395436</td>
<td>Pseudomonas syringae pv. tomato T1</td>
<td>Carocin D Type Nuclease</td>
</tr>
<tr>
<td>ZP_06495421</td>
<td>Pseudomonas syringae pv. syringae FF5</td>
<td>H-N-H Nuclease</td>
</tr>
<tr>
<td>ZP_06499384/5</td>
<td>Pseudomonas syringae pv. syringae FF5</td>
<td>Carocin D Type Nuclease</td>
</tr>
<tr>
<td>YP_237718</td>
<td>Pseudomonas syringae pv. syringae B728a</td>
<td>H-N-H Nuclease</td>
</tr>
<tr>
<td>YP_233421</td>
<td>Pseudomonas syringae pv. syringae B728a</td>
<td>H-N-H Nuclease</td>
</tr>
<tr>
<td>YP_233979</td>
<td>Pseudomonas syringae pv. syringae B728a</td>
<td>Carocin D Type Nuclease</td>
</tr>
<tr>
<td>ZP_05635896</td>
<td>Pseudomonas syringae pv. tabaci ATCC 11528</td>
<td>H-N-H Nuclease</td>
</tr>
<tr>
<td>ZP_05635994</td>
<td>Pseudomonas syringae pv. tabaci ATCC 11528</td>
<td>Carocin D Type Nuclease</td>
</tr>
<tr>
<td>ZP_04586459</td>
<td>Pseudomonas syringae pv. oryzae str. 1_6</td>
<td>H-N-H Nuclease</td>
</tr>
<tr>
<td>Genbank Accession #</td>
<td>Genome Sequence Pathovar</td>
<td>Predicted Activity Type</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>ZP_07263477</td>
<td>Pseudomonas syringae pv. syringae 642</td>
<td>H-N-H Nuclease</td>
</tr>
<tr>
<td>ZP_07266212</td>
<td>Pseudomonas syringae pv. syringae 642</td>
<td>Colicin M Type</td>
</tr>
<tr>
<td><strong>ZP_07263221</strong></td>
<td><strong>Pseudomonas syringae pv. syringae 642</strong></td>
<td><strong>Putidacin L1 Type</strong></td>
</tr>
<tr>
<td>ZP_07231803</td>
<td>Pseudomonas syringae pv. tomato Max13</td>
<td>H-N-H Nuclease</td>
</tr>
<tr>
<td>ZP_07231496</td>
<td>Pseudomonas syringae pv. tomato Max13</td>
<td>Carocin D Type Nuclease</td>
</tr>
<tr>
<td>YP_273195</td>
<td>Pseudomonas syringae pv. Phaseolicola 1448a</td>
<td>Carocin D Type Nuclease</td>
</tr>
<tr>
<td>ZP_07251890</td>
<td>Pseudomonas syringae pv. Tomato K40</td>
<td>Carocin D Type Nuclease</td>
</tr>
<tr>
<td>ZP_07256906</td>
<td>Pseudomonas syringae pv. tomato str. NCPPB 1108</td>
<td>Carocin D Type Nuclease</td>
</tr>
</tbody>
</table>
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Figure 1: Example of growth inhibition experiment, Cell extracts from E. coli expressing Putidacin L1 show zones of inhibition in growth of S. syringae isolate: LMG2222 lawn on growth agar plate.
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Figure 2: N. benthamiana mesophyll cells expressing Syringacin M1+GFP (green), chloroplasts false coloured in red.

References


Exploring pseudomonad bacteriocins: Highly specific protein antibiotics, as a means of creating disease resistant transgenic plants


Introduction
Fresh fruits and vegetables are highly perishable and therefore susceptible to several diseases. Synthetic fungicides have been used for a long time to control postharvest diseases. However, persistent use of these fungicides has resulted in the emergence of resistant strains and also posed more health risks and environmental pollution (Wilson et al. 1997). Therefore, more emphasis has been given to discover sustainable, non-chemical alternative techniques to preserve fresh fruits and vegetables.

A novel approach to extend postharvest shelf-life of fresh fruits and vegetables is the use of edible coatings (Ali et al. 2010). Several studies reported the antimicrobial effects of edible coatings based on natural products against postharvest pathogens of fresh fruits and vegetables (El Ghaouth et al. 1992; Baldwin et al. 1995; Ali et al. 2010).

Gum arabic is a dried gummy polysaccharide obtained from the stems or branches of *Acacia* species and the most extensively used hydrocolloid in industrial sector because of its emulsification properties (Motlagh et al. 2006). Chitosan is another polysaccharide obtained from the exoskeleton of crustaceans, such as shrimps and crabs (No & Meyers 1997). It has become a potent alternative treatment for extending storage life and to control decay of fruits and vegetables due to its natural antimicrobial effects (Baldwin et al. 1995; Ali et al. 2010).
Therefore, the objective of this study was to develop a composite edible coating based on gum arabic and chitosan to evaluate its antifungal potential against postharvest anthracnose of banana and papaya.

**Material and methods**

*C. musae* and *C. gloeosporioides* were isolated from anthracnose lesions on banana and papaya fruits respectively. The diseased areas were disinfected and then placed on Potato Dextrose Agar plates to incubate at room temperature for further analysis.

Gum arabic solutions were prepared by dissolving 5, 10, 15 and 20 g of powder in purified water while chitosan by dissolving 1.0 g of chitosan in 100 ml purified water containing 0.5 ml (v/v) of acetic acid and pH 5.6 was adjusted by adding 1 N NaOH.

For *in vitro* analysis percentage inhibition in radial mycelial growth and conidial germination were observed. While for *in vivo* studies fruits were dipped in spore suspension (1 x 10⁵ spores per ml) and then treated with gum arabic (5, 10, 15, 20%) plus 1.0% chitosan solutions, packed and stored (13±1°C for banana, 12±1°C for papaya, 80% RH) for 28 days. Disease incidence data was expressed as percentage of fruit showing anthracnose symptoms while disease severity was scored following the scale described by Sivakumar et al (2002).

A completely randomized design and analysis of variance were used while treatment means were separated using LSD test at (*P* ≤ 0.05). For *in vitro* analysis four replicates of 20 Petri plates and for *in vivo* analysis 20 fruits per replicate were used.

**Results and discussion**

All the gum arabic plus chitosan concentrations tested significantly (*P* ≤ 0.05) affected the radial mycelial growth and conidial germination of *C. musae* and *C. gloeosporioides* (Table 1, 2). In case of *C. musae* the maximum inhibition in radial mycelial growth (100%) and conidial germination (92.5%) was observed while in
case of *C. gloeosporioides* (86.4%) and (66.2%), respectively, was observed in Petri plates amended with 10% gum arabic plus 1.0% chitosan. While there was no control of radial mycelial growth and conidial germination in control plates. *In vivo* studies also revealed that 10% gum arabic plus 1.0% chitosan was the optimal concentration in controlling decay (80%) in case of *C. musae* and (79%) in case of *C. gloeosporioides* in artificially inoculated bananas and papayas.

The gum arabic and chitosan used together protected the fruits against anthracnose by providing a film onto the surface of fruits and creating a modified atmosphere, delayed ripening process and strengthen cell wall tissues (Dang et al 2008). The chitosan might be acted as a barrier limiting the penetration of germ tube of fungus. Other physiological processes might also been involved to control anthracnose during storage as chitosan has also been reported to induce several host defence mechanisms (El Ghaouth et al 1992).

Thus, it can be concluded from the present study that composite coatings composed of 10% gum arabic and 1.0% chitosan could be an effective tool to control postharvest anthracnose of banana and papaya during storage and therefore, can be particularly suitable in the industry to be use as biofungicide.
### Table 1: Effect of gum arabic and chitosan composite edible coating on percentage inhibition in radial mycelia growth, conidia germination, disease incidence and disease severity of *C. musae*

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Percentage inhibition in radial mycelia growth (%</th>
<th>Conidial germination inhibition (%)</th>
<th>Disease incidence (%)</th>
<th>Disease severity (score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.00 e</td>
<td>0.00 e</td>
<td>100.0 a</td>
<td>5.00 a</td>
</tr>
<tr>
<td>5% gum arabic + 1.0% chitosan</td>
<td>80.2 b</td>
<td>90.0 b</td>
<td>58.0 d</td>
<td>3.00 d</td>
</tr>
<tr>
<td>10% gum arabic + 1.0% chitosan</td>
<td>100.0 a</td>
<td>92.5 a</td>
<td>20.0 e</td>
<td>1.70 e</td>
</tr>
<tr>
<td>15% gum arabic + 1.0% chitosan</td>
<td>58.0 c</td>
<td>80.0 c</td>
<td>60.0 c</td>
<td>3.33 c</td>
</tr>
<tr>
<td>20% gum arabic + 1.0% chitosan</td>
<td>56.5 d</td>
<td>78.6 d</td>
<td>64.0 b</td>
<td>3.50 b</td>
</tr>
</tbody>
</table>

Different letters in columns denote a significant difference (P ≤ 0.05) by LSD test.
Table 2: Effect of gum arabic and chitosan composite edible coating on percentage inhibition in radial mycelia growth, conidia germination, disease incidence and disease severity of *C. gloeosporioides*

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Percentage inhibition in radial mycelia growth (%)</th>
<th>Conidial germination inhibition (%)</th>
<th>Disease incidence (%)</th>
<th>Disease severity (score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.00 e</td>
<td>0.00 e</td>
<td>100.0 a</td>
<td>4.80 a</td>
</tr>
<tr>
<td>5% gum arabic + 1.0% chitosan</td>
<td>29.5 d</td>
<td>24.0 d</td>
<td>58.8 b</td>
<td>2.40 d</td>
</tr>
<tr>
<td>10% gum arabic + 1.0% chitosan</td>
<td>86.4 a</td>
<td>66.2 a</td>
<td>20.5 e</td>
<td>1.60 e</td>
</tr>
<tr>
<td>15% gum arabic + 1.0% chitosan</td>
<td>67.5 b</td>
<td>36.5 b</td>
<td>60.1 d</td>
<td>2.80 c</td>
</tr>
<tr>
<td>20% gum arabic + 1.0% chitosan</td>
<td>47.2 c</td>
<td>28.4 c</td>
<td>64.5 c</td>
<td>3.0 b</td>
</tr>
</tbody>
</table>

Different letters in columns denote a significant difference (P ≤ 0.05) by LSD test.

References


Acute Phase Proteins and Disease Resistance in Broiler Chickens
Emily L. O’Reilly
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Introduction
The acute phase response (APR) is the inducible constituent of the innate immune system and the prominent systemic reaction of an animal to local or systemic disturbances in its homeostasis caused by infection, trauma, stress, surgery, neoplasia or inflammation (Gruys et al. 2005; Cray et al. 2009). The APR is a complex systemic reaction the goal of which is re-establishment of homeostasis and healing (Cray et al. 2009). Acute phase proteins (APPs) are released from the liver during the APR and have varied functions some of which are detailed in table 1. The circulating concentrations of the APPs are related to the severity of the disorder and the extent of the tissue damage. Quantification of their concentration can therefore provide diagnostic and prognosistic information (Murata et al. 2004; Gruys et al. 2005).

<table>
<thead>
<tr>
<th>Acute phase protein functions</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Activate complement</em></td>
</tr>
<tr>
<td><em>Antioxidant</em></td>
</tr>
<tr>
<td><em>Opsonisation</em></td>
</tr>
<tr>
<td><em>Scavenging free haemoglobin iron and free radicals</em></td>
</tr>
<tr>
<td><em>Antibacterial</em></td>
</tr>
<tr>
<td><em>Antiviral</em></td>
</tr>
<tr>
<td><em>Binding cellular remnants and neutralising enzymes</em></td>
</tr>
<tr>
<td><em>Modulate the host’s immune response</em></td>
</tr>
</tbody>
</table>

Table 1: Biological functions of APPs (Gruys et al. 2005; Cray et al. 2009).

Characterisation of APPs in chickens is necessary. Compared to other food production animals knowledge of APPs in chickens is
lacking and this is a significant shortfall owing to the status of the chicken as the world’s most economically significant and widely eaten food animal. In the last 50 years chicken has greatly increased its market share and its popularity continues to rise. In 2009, 91.9 million tons of poultry meat was produced worldwide and the 2010 figure is expected to exceed 94.2 million tons (Watt Poultry Executive Guide to World Poultry Trends, 2010).

Infectious diseases are a threat to the poultry industry affecting growth, productivity and being detrimental to bird welfare. Broilers (meat chickens) are reared in conditions that can contribute to the level and spread of disease within a flock. As such countermeasures to prevent and control infectious disease in poultry are needed. Historically antimicrobials played a major role in disease prevention and control. Concern about the overuse of antimicrobials, disease resistance and the impact this could have on human health led to a ban on the use of antimicrobial growth promoters in the EU (EC Regulation No. 1831/2003). This, together with the emergence of new diseases and antimicrobial resistance means there is a need to identify and implement alternative methods to prevent and control disease in these important food producing animals.

Characterising chicken APPs and any relationship between APP serum concentrations and genetic, phenotypic, nutritional and environmental factors will establish whether this aspect of avian immunity is malleable to genetic selection. If so the selection of chickens with improved immunity may be possible. The APP profiles of diseases posing a particular threat to the poultry industry are also being investigated.

**Methods & Results**

Initial proteomic techniques used in preliminary studies to characterise and quantify APPs included one dimensional sodium dodecyl sulphate-polyacrylamide gel electrophoresis (SDS-PAGE) as developed by Laemmli, (1970), which separates proteins within
the serum according to molecular weight. The individual protein bands were cut from the gel, trypsin digested into peptides and analysed using mass spectrometry. To compare the serum proteins from normal and diseased chickens on a 1D SDS-PAGE gel, residual serum samples from Georgieva et al. (2010) study where birds were experimentally infected with the highly pathogenic coccidial parasite *Eimeria tenella* and *Escherichia coli* were used.

Figure 1 depicts a 1D-SDS gel, bands not present in the control birds, but present in the diseased birds are of interest. These are the proteins that have increased in concentration as a response to infection.

Immunoassays are being utilised and chicken specific assays are being developed, to allow quick and accurate measurement of specific APPs. In a separate study two groups of chickens were sampled from a commercial broiler farm. Blood samples were taken immediately post mortem from two groups of chickens: control chickens with no obvious signs of disease and culled chickens, birds removed from the flock due to generalised ill
Mehdi Maqbool

A novel composite edible coating as a biofungicide to control postharvest anthracnose of banana and papaya

health. The APPs PIT54, a potent antioxidant and antimicrobial protein and ceruloplasmin, another antioxidant protein involved in copper transport and iron homeostasis were measured. Figures 2 and 3 show the mean concentrations of PIT54 and ceruloplasmin respectively from the two groups of birds.

![Figure 2: Mean (±SEM) serum PIT54 from culled and control birds.](image1)

![Figure 3: Mean (±SEM) serum ceruloplasmin from culled and control birds.](image2)

In experimentally induced infections PIT54 and ceruloplasmin have been shown to increase significantly (Garcia et al. 2009; Georgieva et al. 2010; Nazifi, et al. 2010). Results from this initial study show
that culled birds, from a commercial farm with non-specific disease also have statistically significant increases \( (P=0.05) \) in PIT 54 and ceruloplasmin when compared to apparently healthy birds within the same flock.

**Discussion**

The APP changes that occur in avian species in response to disease are poorly documented when compared to what is known of other farm animals. Studying APPs in chickens represents a challenging area of research owing to the distant phylogenetic relationship between aves and mammals. If successful then as well as well as optimising production performance of broilers in the face of increasing disease challenge, the health and welfare of these birds will also improve.

This research could have other applications in the poultry industry. The antimicrobial effects of APPs could be used for disease control and prevention. Measuring APPs could increase sensitivity of meat inspection identifying diseased birds before they enter the food chain. Measuring APPs will aid in monitoring flock health, providing an early indicator to the presence of sub clinical disease. They may also be used as a prognostic indicator as to the likelihood of a flock recovering from disease outbreak.

Food production must be sustainable and as poultry production is set to increase further, in line with consumer demand and an increasing world population, this is an important species on which to focus. Modern broiler breeds of chicken are unique among farm animals for their exceptionally short production cycles and low feed conversion ratios, i.e. the amount of food needed for them to grow is very small. This factor in itself is likely to maintain and increase the popularity of the broiler chicken as a source of meat owing to the global increase in grain prices.

This research project will contribute to reducing disease and improving the welfare of these birds thus ensuring that the poultry industry is able to keep up with global demand by producing
plentiful, safe, reasonably priced food for the expanding world population.

Acknowledgements

BBSRC

Aviagen

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Watt Poultry Executive Guide to World Poultry Trends
http://www.wattagnet.com/
Mehdi Maqbool

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Genetic Modification

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The curious case of Bt brinjal: Why isn’t India growing genetically engineered eggplant?

Julia Freeman
University of British Columbia

Introduction
This paper contrasts the widespread use of Bt cotton in India with the recent moratorium imposed on Bt brinjal (eggplant). Why was the release of a genetically engineered food crop suspended in this way, despite the near ubiquity of transgenic cotton? The rejection of Bt brinjal is not simply as India’s first genetically engineered food crop, though this lends a critical valence in anti-GE narratives. Several factors have lead to the moratorium – most notably, the conspicuous absence of farmer consultation in the regulatory process.

GE agriculture in India, briefly.
India has been growing genetically engineered (GE) cotton for nearly a decade. These hybrids contain genetic material from the soil bacterium bacillus thuringiensis (Bt), lending increased capacity to resist pests. Benefits of this trait are a reduction in the costs of pesticide usage for farmers, and improved profitability by reducing the loss of crops to bollworm and other pests (Zilberman, Ameden & Qaim 2007). Opponents of GE-farming critique its industry led by multinational corporations, uncertain science regarding how to measure its effects, and potential environmental or health risks (Sahai 2005; GRAIN 2007; Kuruganti 2009).

Yet the technology has proven popular with farmers. More than 90% of the cotton grown today is Bt cotton, and more farmers than ever before have take up the crop since the arrival of these pest resistant hybrids (ISAAA Brief 41 2009). Indeed, anticipation for Bt cotton was such that farmers in Gujarat started planting unregulated seeds prior to their commercial release (Herring 2007). While we might expect this first encounter to have paved the way for Bt brinjal, it has not proven to be the case. As such it
provides a remarkable example of the range of stakeholders implicated in the global south’s GE debates and the complex negotiations involved in weighing future directions for agricultural development.

A contested eggplant

Brinjal was an early contender for the Bt trait because it is prone to damage by the fruit and shoot borer (FSB) that can lead crop losses of 70% (MoEF 2009). Heavy application of pesticides is only marginally helpful and leaves toxins on the food alongside other environmental effects (e.g. destroying beneficial insects) (MoEF 2009). Moreover, early social research found that farmers assessed the potential economic benefits of Bt brinjal to outweigh its risks, and anticipation of the fledgling crop was widespread (Chong 2005).

The emergent crop attracted negative attention as well. The Coalition for a GM Free India launched the “I am no lab rat” campaign (see: http://www.iamnolabrat.com/) to alert consumers and announce mobilizations. Protest was significant enough for Minister of the Environment and Forests, Jairam Ramesh, to overturn regulators’ decision to commercialize Bt brinjal on October 14, 2009 (Staff reporter, The Hindu, 2010). Ramesh then consulted with stakeholders in seven cities around the country in early 2010, leading to the current moratorium (Ramesh 2010).

Accounting for the suspension of Bt brinjal

Despite the uptake of Bt cotton, a sheen of risk remains on GE crops. For example, concern lingers over reports of sheep ostensibly killed from grazing in Bt cotton fields. However technically flawed - the Bt toxin does not perform in mammalian gut as it does in those of lepidopteran insect populations (Herring 2008) – these narratives continue to raise the specter of doubt (e.g. Sadeque 2008). Likewise, the tragic suicide of thousands of indebted farmers has become implicated in this debate, though it is rarely noted that these deaths began long before any Bt crop was sown (Shiva, Jafri & Pande 2000).
The regulatory regime has also met considerable critique, for failing to control the release of Bt cotton and for a lack of operational transparency (Scoones 2006). Hence, civil society employed public interest litigation as means to insert themselves in the regulatory process and transform its structure (Freeman, Satterfield & Kandlikar In Press).

Another important distinction is that the crop does not appear to rally farmers as a mobilized and coherent population of ‘brinjal producers’ in the same way as cotton has. Brinjal farmers tend instead to grow many other kinds of vegetables, and so negotiate a more diffuse set of interests. There is also less pressure upon state governments to advocate on behalf of this dispersed population in the way they sometimes have for Bt cotton growers (e.g. Kameswara Rao 2007). Moreover, stakeholder consultations, while attended by some farmers, were exclusively located in urban centers. This restricted their accessibility to marginal farming populations in rural areas. Alternatively, the recent formation of anti-GE associations and modes of resistance (e.g. the GM Free Coalition and the ‘I am no lab rat’ website) lend a newfound focus and convergence for those in opposition to transgenic agriculture.

India is the country of origin for brinjal (Choudhary & Gaur 2009), and some argue the biodiversity of eggplant varieties will be jeopardized if GE hybrids are widely grown. Brinjal is also a widely consumed vegetable with ayurvedic qualities (ISAAA 2010). So while Bt brinjal’s distinction as a food crop cannot singularly account for its suspension, its risks are embodied at both individual and national levels, lending a heightened symbolic valence to the anti-GE campaign.

These factors contribute to the current moratorium, despite the potential gains Bt brinjal may offer marginal farmers. In this case, advocacy regarding the anticipated benefits was muted and diffuse in comparison to the concerted, vocal campaigns emerging from Indian civil society. Of course, with complex debates such as this,
The curious case of Bt brinjal: Why isn’t India growing genetically engineered eggplant?

matters are rarely ‘resolved’ and put to rest, but rather conform to cycles of resistance (Tarrow 2005).

**Conclusion**

Transgenic food crops have mobilized India’s civil society, though it has been demonstrated that edibility is only one factor among many that distinguishes Bt brinjal’s suspension from Bt cotton’s ubiquity. A more crucial distinction is the marked absence of a coherent farmers’ perspective. Should the GE debate resume again, the changing regulatory regime would do well to seek the input of marginal farmers as part of their stakeholder consultations.

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Ministry of Environment and Forests, Genetic Engineering Approval Committee 2009, Report of the Expert Committee (EC-II) on Bt Brinjal Event EE-1 Developed by: M/s Maharashtra Hybrid Seeds Company Ltd. (Mahyco), Mumbai; University of Agricultural Sciences (UAS), Dharwad; and Tamil Nadu Agricultural University (TNAU), Coimbatore, Government of India, New Delhi.


Julia Freeman
The curious case of Bt brinjal: Why isn’t India growing genetically engineered eggplant?


Breeding better quality peanuts: Benefits for industry, consumers, and food security

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University of New South Wales

Introduction
Australian agri-food industries are challenged by increasingly competitive trade conditions and rely on product differentiation, value-adding, and niche-marketing of ‘quality rather than quantity’ to compete in the global market. At the same time, food shortages associated with population growth and faltering food production are set to impact the world’s poorer communities, particularly in developing countries where starvation and micronutrient malnutrition already exact a devastating social toll. This paper discusses how genetic improvement of nutritional quality can benefit industry stakeholders and consumers, and also contribute to global food security, with reference to the author’s research on peanuts as an example.

Plant breeding and food security
Genetic improvement has long been a key strategy by which primary industries have achieved production goals. Selection criteria have traditionally related to productivity, for example, maximising yield potential, reducing losses to pest and disease, and increasing adaptability to environmental conditions to allow expansion into new production zones. Breeding for nutritional quality is relatively recent, and the history of the Australian peanut improvement program is illustrative: since the program commenced in 1977, emphasis has progressed from drought adaptation and yield improvement in the 1990s, to a focus on kernel quality since 1995 that saw a major shift in kernel oil composition to a high oleic acid platform, resulting in shelf life and health benefits for consumers (Rachaputi & Chauhan, 2010).

Breeding for nutritional quality brings commercial opportunities, but can moreover benefit public health, particularly where
malnutrition is a problem. For example, development of plant varieties with enhanced levels of essential vitamins or minerals presents a means to improve dietary micronutrient intake, alongside traditional interventions such as supplementation, fortification, and dietary diversification (White & Broadley, 2005). In seed or grain crops, such ‘bio-fortification’ has the added advantages of boosting productivity in nutrient-deficient soils, and represents technology that is readily adopted by farmers because no change in agronomic practice or new capital investments are required (Welch & Graham, 2005).

‘Functional food’ traits are non-essential constituents that promote health by reducing the risks of chronic conditions and optimising immune function. To date, development of functional food products has often relied on novel processing (e.g., pro-biotics, phytosterol-enhanced margarine), or mere measurement and marketing of existing qualities (e.g., numerous antioxidant ‘superfoods’). Yet plant breeding could increase the naturally-occurring levels of functional food traits in primary foods, for more effective delivery of health benefits to consumers. Increasing nutritional ‘bang for the buck’ may be particularly useful in communities afflicted by food shortages or food price crises.

Investigations into breeding healthier peanuts

Peanuts are bred conventionally in Australia, which means that new genetic combinations only arise from the natural processes of sexual recombination and segregation. At a fundamental level then, the breeding potential for specific traits depends largely on the genotypic variation among the population and the stability of trait expression. As part of this initial exploratory research into breeding potential, the genotypic variation and genotype-by-environment (G×E) interaction affecting essential mineral concentrations and antioxidant activity in peanut kernels were investigated, as nutritional qualities of potential value to the Australian peanut improvement program.
Breeding potential for essential minerals

Kernel concentrations of 9 essential minerals (B, Ca, Cu, Fe, K, Mg, Mn, P, and Zn) in 56 diverse peanut genotypes were measured by inductively coupled plasma-optical emission spectroscopy (ICP-OES) after closed acid microwave digestion. There were promising levels of variation (>10%) for most of the tested elements, particularly Ca and Mn (Table 1). A representative selection of 9 genotypes was harvested from 5 distinct environments in the main peanut production areas of northern Australia. These were analysed by ICP-OES and ICP-mass spectrometry for a larger range of minerals (B, Ca, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Se, and Zn). Genotype, environment, and G×E interaction were significant (ANOVA P<0.05) for almost all elements. A G×E interaction can introduce uncertainty into the selection process if it leads to re-ranking in different environments. However, the significance of the main effects confirmed that there were consistent genotypic trends in mineral content despite variations in growing conditions. Furthermore, there may be opportunities to manipulate mineral concentrations by agronomic management. For example, there was ~3-fold more Mo in ‘Middleton’ and ‘Sutherland’ kernels than other genotypes, and 3- to 10-fold more Mo in kernels from Bundaberg than from other locations (Table 2). It is feasible that combining genetic improvement and agronomic management could provide a strategy to consistently produce micronutrient-enriched peanuts. This study is discussed in more detail in Phan-Thien et al, (2010).
Table 1: Variation in (a) mineral concentrations\(^{a}\) and (b) antioxidant activity across 32 peanut genotypes (n=96).

### (a)

<table>
<thead>
<tr>
<th>Essential mineral</th>
<th>Mean ± SD</th>
<th>RSD %</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>15.1 ± 2.1</td>
<td>14</td>
</tr>
<tr>
<td>Ca</td>
<td>658 ± 116</td>
<td>18</td>
</tr>
<tr>
<td>Cu</td>
<td>7.0 ± 1.2</td>
<td>17</td>
</tr>
<tr>
<td>Fe</td>
<td>13.2 ± 1.4</td>
<td>11</td>
</tr>
<tr>
<td>K</td>
<td>6772 ± 834</td>
<td>12</td>
</tr>
<tr>
<td>Mg</td>
<td>1589 ± 162</td>
<td>10</td>
</tr>
<tr>
<td>Mn</td>
<td>25.5 ± 6.0</td>
<td>24</td>
</tr>
<tr>
<td>P</td>
<td>3734 ± 487</td>
<td>13</td>
</tr>
<tr>
<td>Zn</td>
<td>27.6 ± 3.4</td>
<td>12</td>
</tr>
</tbody>
</table>

### (b)

<table>
<thead>
<tr>
<th>Antioxidant activity</th>
<th>Mean ± SD</th>
<th>RSD %</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABTS(^{b})</td>
<td>7.3 ± 3.4</td>
<td>47</td>
</tr>
<tr>
<td>DPPH(^{c})</td>
<td>2.4 ± 0.6</td>
<td>25</td>
</tr>
<tr>
<td>FC(^{c})</td>
<td>8.8 ± 1.7</td>
<td>19</td>
</tr>
<tr>
<td>ORAC(^{b})</td>
<td>27.3 ± 6.4</td>
<td>23</td>
</tr>
</tbody>
</table>

\(^{a}\) concentrations in µg g\(^{-1}\) dw.

\(^{b}\) in µmol Trolox equivalents g\(^{-1}\) dw.

\(^{c}\) in µmol gallic acid equivalents g\(^{-1}\) dw.
Table 2: Selected examples of (a) genotypic and (b) environmental differences⁠¹ in mineral concentrations⁠² from G×E study (n=156).

(a)

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Ca</th>
<th>Mo</th>
<th>Na</th>
</tr>
</thead>
<tbody>
<tr>
<td>D147-p3-115</td>
<td>570</td>
<td>cde</td>
<td>0.23 b</td>
</tr>
<tr>
<td>D175-3-p17-3</td>
<td>768</td>
<td>a</td>
<td>0.45 ab</td>
</tr>
<tr>
<td>D192-p397-1</td>
<td>502</td>
<td>e</td>
<td>0.38 b</td>
</tr>
<tr>
<td>D193-p3-6</td>
<td>565</td>
<td>cde</td>
<td>0.38 b</td>
</tr>
<tr>
<td>D193-p3-8</td>
<td>524</td>
<td>de</td>
<td>0.38 b</td>
</tr>
<tr>
<td>Middleton</td>
<td>667</td>
<td>b</td>
<td>0.75 a</td>
</tr>
<tr>
<td>Page</td>
<td>630</td>
<td>bc</td>
<td>0.30 b</td>
</tr>
<tr>
<td>PCA213</td>
<td>591</td>
<td>cd</td>
<td>0.26 b</td>
</tr>
<tr>
<td>Sutherland</td>
<td>553</td>
<td>de</td>
<td>0.77 a</td>
</tr>
</tbody>
</table>

(b)

<table>
<thead>
<tr>
<th>Environment</th>
<th>Ca</th>
<th>Mo</th>
<th>Na</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bundaberg RS⁠³</td>
<td>606</td>
<td>ab</td>
<td>1.33 a</td>
</tr>
<tr>
<td>Kairi RS 1</td>
<td>619</td>
<td>a</td>
<td>0.20 b</td>
</tr>
<tr>
<td>Kairi RS 2</td>
<td>560</td>
<td>b</td>
<td>0.15 c</td>
</tr>
<tr>
<td>Kairi RS 3</td>
<td>595</td>
<td>ab</td>
<td>0.40 b</td>
</tr>
<tr>
<td>Taabinga RS</td>
<td>608</td>
<td>ab</td>
<td>0.12 c</td>
</tr>
</tbody>
</table>

⁠¹ different lowercase letters denote a significant difference (P<0.05).
⁠² concentrations in µg g⁻¹ dw.
⁠³ DEEDI Research Station.

Breeding potential for antioxidants

Kernel antioxidant activity of 32 peanut genotypes was measured by four in vitro assays that reflect the radical-scavenging or
reducing power of the extract (Huang et al, 2005): ABTS, DPPH, Folin-Ciocalteu (FC), and ORAC. Oxidative damage to tissues is associated with a range of conditions, such as cancer, cardiovascular disease, and neuro-degeneration (Diplock et al, 1998), so high antioxidant activity is a good indicator of potential health-promoting properties. The peanuts displayed promising levels of genotypic variation according to all four assays. ORAC was the most sensitive assay used and indicated 23% variation across the tested genotypes, or ~3-fold difference between the highest- and lowest-ranked genotypes (Table 1). Ten representative genotypes grown in five environments were tested by FC and ORAC assays to explore the G×E interaction. Genotype and environment were significant (ANOVA P<0.05), but the G×E interaction was not. This suggests there may be strong genetic control of kernel antioxidant activity. Peanut antioxidant activity may therefore be a promising avenue for further breeding-related research.

**Conclusions**

This research has found promising levels of genotypic variation in the essential mineral concentrations and antioxidant activity of peanut kernels, indicating there are good opportunities to manipulate the phenotype despite environmental influences, and that further breeding-related research is worthwhile. The development of micronutrient-enriched or functional food peanuts would benefit industry stakeholders by enhancing opportunities for value-adding and niche-marketing, and benefit consumers with greater availability of healthier food products. From a food security perspective, foods with a value-added nutritional profile may contribute to alleviation of micronutrient malnutrition and optimisation of health in the face of threatening food shortages and food price crises.

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Are supermarket food prices more or less likely to be discounted the longer they remain without a sale?

Hao Lan
The University of Nottingham

Motivation
Everyone buys food. Around the world, increasingly we buy our food from supermarkets rather than traditional food markets such as local grocers and food markets, whose importance in the food chain is waning. Understanding pricing in supermarkets is thus becoming increasingly relevant for both consumers and producer of food with implications not only for food consumption and its production and distribution. One important aspect of supermarket pricing behaviour is that they tend to use more promotional discounting (sales) than their traditional counterparts and evidence shows that they account for around 40% of all price variation in UK food retailing (Lloyd et al, 2009). Sales, which typically last 4 weeks for food products, have been the subject of much recent research (Berck et al 2008, Nakamura & Steinsson, 2008) but little is known about the duration of non-sale prices, what we term ‘regular’ prices. This study analyses the duration of these regular price spells to investigate the pattern of sales behaviour in the food retailing market. In particular, we address whether sales are more or less likely the longer the regular price prevails, and find that contrary to some popular theories, the longer the regular price persists, the less likely it will be discounted.

The scanner dataset
The research uses a high-frequency disaggregate-level scanner dataset representing a comprehensive panel of weekly UK supermarket prices on over 500 food products in 15 categories over a 2.5 year (2001-4) period. Three dimensions of the database are particularly interesting: products are evaluated at a highly specific – barcode - level in up to seven of the UK’s major food retailers (Tesco, Sainsbury, ASDA, Safeway, Somerfield, Kwik Save
Are supermarket food prices more or less likely to be discounted the longer they remain without a sale?

and Waitrose) and include both branded and own label products. Each time series of prices is identified at the product-supermarket level with a unique product code (UPC). Figure 1 illustrates the prices of one such UPC, ‘Del Monte Orange Juice Tetra 1L 3Pack’ in Safeway, which experiences six sales during the sample each of which lasts within 4 weeks. As can be seen, some regular price spells are quite short possibly lasting only 1 week while other are relatively long having a duration in excess on one year. Other spells of regular prices for this UPC last between 10 and 20 weeks. This research seeks to investigate the presence of patterns in the duration of these spells in regular prices.

Figure 1: Food price observations from a UPC

Theories of sales
Varian (1980) describes a random sales pattern in which sales occur randomly in each period. In contrast, Sobel (1984) and Pesendorfer (2000) consider that sales occur periodically over time since demand accumulated gradually. Hosken and Reiffen (2007) suggest that a product’s durability (shelf-life) is significantly
related to sales; Berck et al (2008) find that own-label products are promoted less than brands.

**The methodology**

Using a statistical approach known as duration (or survival) analysis we analyse the duration of (6,007) regular price spells in 1,704 UPCs to identify pattern of sales behaviour. Although common in biomedical science and engineering, duration analysis has been used little in the analyses of prices (Fougère, 2007).

Using a parametric Maximum Likelihood approach (Jenkins, 2005; Kalbfleisch & Prentice, 2002; Kiefer, 1988) we create a hypothetical distribution of price duration spells that gives the observed data the greatest probability of occurrence. From this we derive the **hazard function**, which estimates the probability that a product goes on sale. This is commonly known as the ‘hazard’, which we can make conditional on both time (the length of time since the last sale) and state-dependent influences (product category, supermarket chain, format and brand status). For every hazard function there is a corresponding **survival function** showing the probability that regular price spells persist. Plots of these functions portray the relationships in an easily interpretable manner.

**Empirical results**

The estimated hazard and survivor functions are illustrated in Figures 2 and 3 show that:

- The hazard is a non-monotonic curve which rises at the 1-week duration; reaches a peak at 2-week duration and then falls as the spell duration increases.
- The highest hazard is approximately 4%. Because the rate is so small, most products remain at regular prices for long periods of time, as emphasised by the survival function which shows that around 40% of regular price spells last one year.
Are supermarket food prices more or less likely to be discounted the longer they remain without a sale?

These results are in contrast to received theory, which suggest that the hazard function should either rise (suggesting periodic sales and demand accumulated) or remain flat (sales are random).

Figure 2: Hazard rate of food prices since last sale

Figure 3: Survival rate of regular food prices since last sale
Are supermarket food prices more or less likely to be discounted the longer they remain without a sale?

These results are also robust across product categories, formats and brand status, and to a lesser extent by supermarket. Although the shape of the hazard function is remarkably similar there is statistically significant variation in the height (probability) of each hazard function on the graph which suggests:

- Regular price spells last longer for durable foods (tinned and ambient products) than perishable (‘fresh’, frozen) foods (Figure 3).
- Branded products are promoted more often than own-label products

Results (see Figure 6) also underline the importance of the retailer on the duration of regular prices (and by implications the use of sales). Whereas most supermarket chains use sales similarly ‘Hi-Lo’ and everyday low pricing strategies of Safeway are clearly apparent.

**Figure 4: Sales behaviour across product durability**
Are supermarket food prices more or less likely to be discounted the longer they remain without a sale?

**Figure 5: Sales behaviour by brand status**

**Figure 6: Sales behaviour across major food retailers**

**Conclusion**
In this paper, the preliminary results of a duration analysis of regular (non-sale) pricing on food are reported. While we all have
Are supermarket food prices more or less likely to be discounted the longer they remain without a sale?

an interest in knowing when the next sale on food will happen, understanding sales behaviour in a modern supermarket is an essential aspect of supermarket pricing. Contrary to received economic theory we find that the longer a regular price remains, the less likely it is that the food product will be promoted. This finding is robust to product category, format and brand status, although less so by retailer, where clear differences in sales strategy are apparent. The study is on-going and aims to offer some explanation for the sales patterns in food retailing. With a deeper understanding of supermarket pricing we are better placed to address some of the key issues in global food security that affect both the consumers and producers of food.

Reference


Hao Lan
Are supermarket food prices more or less likely to be discounted the longer they remain without a sale?


Australia’s role in achieving global food security: to what extent can reform of the research and development tax concessions contribute?

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Introduction
Food security, environment and agriculture have emerged as a new socio-legal debate, but rarely in the context of taxation. On point with the U21 conference topic ‘food’ this paper provides an overview of how food security could be achieved sustainably by analysing the role of Research and Development (R&D) tax law, policy and design in the area of agriculture. Building on the taxation mechanisms Australia already has in place, this paper argues that reform of the federal R&D tax concessions can assist in achieving global food security.

Food security
Food security exists when the four elements of availability, access, stability and use are achieved simultaneously (FAO 2008, p. 1). When one of these elements is lacking, it can result in food insecurity. The peaking of the global food crisis in 2008 is a recent example of the demand for food exceeding its growth in supply (FAO 2008, p.9). Comprehensive agricultural reports have been conducted by the International Assessment of Agriculture Knowledge, Science and Technology for Development (IAASTD 2008), The World Bank (The World Bank 2008), and the United Nations (UNEP 2007). These reports recognise that current commercial farming practices need to change. The long term solution to global food insecurity involves strategies that address the need for new technologies to increase agricultural productivity, while being sustainable from a financial, environmental and social perspective.
Victoria Roberts
Australia’s role in achieving global food security: to what extent can reform of the research and development tax concessions contribute?

A key theme throughout these reports and one of the options for action is for governments to increase their funding of R&D in agriculture (IAASTD 2008, p.10-11). Although Australia has not signed the IAASTD report, the government recognises the importance of ‘...assisting other countries to address these issues through collaborative agricultural research, extension and training, given that many developing countries experience similar agricultural production and environmental challenges as Australia’ (Pyper 2008, p.144).

Australia’s research and development tax concession
In 1985 the Australian government introduced the Research and Development Tax Concession. Its purpose is to encourage R&D activities to make Australian industry highly innovative and competitive (AusIndustry 2010). Currently the federal R&D tax concession comprises a tax deduction of up to 125 per cent for R&D expenditure; or 175 per cent over a three year average; a 175 per cent deduction for eligible international R&D undertaken in Australia; and a tax offset for small businesses undertaking R&D (ATO 2010).

In August 2008, the Australian government released ‘Venturous Australia’, a panel review of Australia’s national innovation system to ensure Australian innovation plays a key role in boosting productivity and global competitiveness (Cutler 2008). The report outlines ‘agriculture and food security’ as a national priority for innovation which requires immediate attention (Cutler 2008, p.144). Cutler (2008 p.82) also recommended that Australia’s R&D tax concession be changed from a tax deduction to a tax credit. Further research conducted by the Australian Centre for International Agricultural Research (ACIAR 2011) recommends investment in R&D to enable better technology for increased yields, whilst minimising agricultural impacts on the global environment. In 2010, ‘Australia’s Future Tax System Review’, a government commissioned review of Australian taxes, acknowledged the impact of population growth, the fragility of ecosystems and the strong
link between economic growth and environmental sustainability. It concluded that the tax system could play a greater role in influencing sustainable policy outcomes (Henry 2009, pp. 9-10).

In May 2009, the Government announced the R&D tax credit to commence from 1 July 2010. This will include a 45 per cent refundable tax credit for small companies (equivalent to a 150 per cent deduction) and a 40 per cent non-refundable tax credit to large companies (equivalent to a 133 per cent deduction) (AusIndustry). This reform is still being finalised and is a result of much community and industry input.

**The role of Australian agriculture**

Australia plays a vital role in the global food supply, exporting 60% (in volume) of total agricultural production (DAFF 2010, p.7) much of which helps feed the 6.9 billion people in the world (U.S. Census Bureau). Australia’s agricultural contributions could assume even greater significance, with international literature forecasting the impact of climate change could leave many developing countries with diminished productive agriculture (Dinar et al 2008). Considering almost all future population growth is projected to be in the developing world this creates a humanitarian quandary (UN 2009) unless existing food exporters can increase capacity.

Australia’s capacity to increase export markets in a sustainable manner appears attainable. Currently Australia achieves its large contribution to global agriculture with only 4 per cent government support compared to the OECD average of 22 per cent government support (OECD 2010, p. 46). This highlights the significant scope the Australian agricultural industry has for extension of R&D tax incentives. Targeted tax incentives can encourage further Australian agricultural production, using the latest R&D science, technology and farming practices, whilst minimising Australia’s environmental footprint, increasing export markets and thereby contributing to global food security.
Conclusion

There appears to be general consensus that the ideal solution to food insecurity requires global co-operation to increase R&D investment in agriculture. Critical to achieving any global solution, are the practical steps determining how; by what means can this solution be realised? My research involves inductive reasoning to argue that an appropriately reformed R&D tax concession targeted at generating sustainable agricultural innovation in Australia can assist. Taxation literature is awash with information on R&D tax concessions but is remiss on analysis linking R&D tax concessions and food security. Analysis of the role Australian R&D tax concessions can play in achieving global food security forms an original contribution to the body of knowledge.

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Victoria Roberts

Australia’s role in achieving global food security: to what extent can reform of the research and development tax concessions contribute?


To see the change of China’s hukou system in terms of food supplying

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Unlike population registration system in many other countries, the Chinese Hukou system was designed not merely to provide population statistics and identify personal status, but also to directly regulate population distribution and serve many other important objectives desired by the state (Chan 1999). Actually, the hukou system is a major tool of state to control resources distribution in China. In view of food supplying change from rationing to free transaction since 1949, we can see the vanishing of an important function attached to hukou system. The hukou system was established in cities in the PRC in 1951 (Ministry of Public Security 1951) and extended to the rural area in 1955 (Ministry of Internal Affairs 1955). Since 1955, hukou system had become the basis of food rationing under central planning economic system. Under such an economic system, central government rationed all kinds of goods include rice, cloth, meat, oil, while hukou system is the basis (Tian 2009).

All PRC nationals’ personal Hukou status is classified by two related parts in mainland China: one by residential location and one by socioeconomic eligibility (often confusingly called “agricultural”/“non-agricultural”) (Chan 1999), this paper point to the latter. This classification determines one’s entitlement to get the state-subsidized grain and other privileges (Chan 1999). Citizens with non-agriculture (feinongye) hukou were entitled to have state-subsidized but rationed grain supply, while people with agriculture (nongye) hukou was out of the state-subsidized grain. This qualification was attached to one’s hukou registration (State Council 1955). Central government supplied rationed state-subsidized grain to those non-agriculture hukou holders each month, including rice, meat, oil and some other necessary food. On the contrary, agriculture hukou holders had to support themselves.
To see the change of China’s hukou system in terms of food supplying

The superiority of non-agriculture hukou became extremely obvious during 1959 to 1962, when China suffered from “three-year nature disasters”, China was facing severe shortage of food. Especially for those agriculture hukou holders, they rarely harvested anything during these three years. National state centralized goods and materials in cities to guarantee the supply of state-subsidized grain to those non-agriculture hukou holders, which made the situation of agriculture hukou holders became worse. That is, your hukou status had decided whether you were hungry or not.

Food rationing was one of the most important attached functions of hukou system. As China has gradually transferred from centrally planned economic system to socialist market economic system since 1978, foreign trade becomes available in China. The situation of food supplying becomes better. Though food rationing still exist, more and more goods started to exchange in the market. Food rationing on basis of hukou system status was gradually dying away.

As food supplying became more and more, and economy in china become much better as well. Everyone could buy food or any other goods from shops freely as long as you have money. Agriculture hukou holders could also buy the same food as non-agriculture hukou holders. The difference on food supplying between agriculture and non-agriculture hukou status totally disappeared. Hukou status is no longer the basis of food supplying. For that ground, the eager to transform from agriculture hukou to non-agriculture hukou became weaker. The agriculture hukou even become more attractive sometimes, it is because that each agriculture hukou holder could have certain areas of farmland in the countryside. The attached function of hukou has also changed from food rationing to others, such as social security, education and employment. In early time, when Chinese people do not have enough food to maintain their life, the key motivation to get non-agriculture hukou is to be covered by state-subsidized grain supply network. Now, the motivation to get non-agriculture hukou has
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To see the change of China’s hukou system in terms of food supplying

changed to get more citizenship, which would offers more than food. It suggests that as the economic development, China is not lack of food any more, on that ground, people will pay more attentions to their life standards or other entitled citizenship. That is why the attached function of hukou system has changed as the change of food supplying.

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Urbanization and its impact on food shortage

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Introduction
Urbanization is a process in which the proportion of total population living in urban areas has gone up. China’s urbanization level has reached 49.68% in 2010 and the average level of OECD countries is above 70%. Usually, urbanization is regarded as a sign of development and modernization, but it is not all that good as we normally think. Basically, the urbanization process has a negative impact on the food supply primarily in three ways: limited freshwater, smaller rural population and less arable land. These three channels work together to make the food shortage problem even worse.

Results and discussion
The increasing need of freshwater in urban areas
As the urban population increases, the need of freshwater in urban areas has piled up great pressure. Historically, all civilization originated from the watershed located near rivers and the availability of freshwater is an important limit to the growth of cities. Also, freshwater is a crucial factor in agricultural production and it is seen as “lifeblood” for food security. Given no technological progress, the demand of freshwater for agricultural use will increase by about 70-90% in the next 50 years (Mao 2005). Throughout the 20th century, the amount of water for urban use has risen from 21.5 billion cubic meters in 1900 to 381 billion cubic meters in 2000(Yin 2009). Most importantly, its growth rate has far exceeded that of the amount utilized for agricultural use. Since industrialization always come with urbanization, the amount of freshwater for industrial use has grown more than 17 times during the last century, which is also faster than that of agricultural use. Thus, urbanization and industrialization have raced to seize a large proportion of limited freshwater resources which could have been put into food production.
Labour shortage in the countryside
Because of the big difference of economic and social status between rural and urban residents, a growing number of peasants have poured into cities since 1980s. The “hukou” system (literally, Household Registration System) now has less influence on their decision of migration. Migrant workers are attracted by the great pull from metropolis and cities in the eastern part of China. As a result of the relatively higher wages, they would rather do unskilled jobs in low working conditions and sign illegal contract with their employers, than go back to the countryside and work on the farm (Carter 1997). Furthermore, the second-generation migrant workers follow their parents staying in the city and a large proportion of them even lose the basic farming skills, which prevents them from going back to farm work. It is estimated that China’s population will reach its peak at about 1.6 billion in 2035 (Shen 1998). However, due to the huge amount of migration, the total number of rural residents has already been falling down since the beginning of 21st century, while the size of urban population will continue to grow until 2060s. As labour and capital are two fundamental inputs in production function, the decline of the absolute number of farmers can be a potential problem.

The decreasing number of arable land
Arable land is the basis of food production. However, as the urbanization proceeds, more built-up area has taken up more arable land than expected. The large supply of fresh ground has done little to prevent the housing bubble from growing, while the unlimited land reclaiming has occupied too many peasants’ land which could have been used for food production. "Land Crisis" has also been worsened by the pollution and contamination due to the industrialization process, which is closely accompanied by urbanization. Since the mid-1980s, the conversion of land to non-agricultural use in China has been arguably the most widespread in the country’s history (Ho 2004). Conversation tillage has been put forward by National People’s Congress of P.R. China as a state policy since 1991 and it was written into Land Management Law in
1998. Nevertheless, the problem hasn’t seen any sign of recovery. China’s government has set a baseline of 1.8 billion \textit{mu} (about 120 million hectares, 1 \textit{mu} = 0.0667 hectare) for arable land, but the total area of tillage has been approaching on this warning level.

Urban agriculture can be one of the solutions to the food supply in towns and metropolis. The concept first came into public in the 1960s when France made a geographical report of urban and suburban agriculture in central Africa. The primary difference between urban agriculture and rural agriculture is: urban agriculture has blend in the urban economy and ecological system and it has been deeply rooted in the urban area and interact with each other (Bakker et al 2000). The advantages of growing crops in urban and suburban areas include reducing people’s reliance on the fluctuating food market. Also, it reduces the need of rural production in dry seasons. Besides, the transport cost of urban agricultural could be much lower than rural food production. Take Shanghai for example, the agricultural sector only contributes 2% to GDP of the whole economy, while it plays a really important part in the city’s food supply. Of 8.5 million working population in Shanghai, about 41% are working in the agricultural sector. Around 2 million tons of grain products are produced in Shanghai. Also, nearly all the diary product and 90% of eggs sold in Shanghai are produced by Shanghai itself (Giradet 1999).

**Conclusion**

Generally speaking, my point of view is that urbanization has a negative effect on the crop production and makes food shortage problem even worse, although urbanization has been regarded as a beneficial and necessary step into modernization by many economists. China’s government announced that the urbanization level will reach 70% in 2050, which presents a huge challenge for policy makers. Anyway, we should call for a balance between food production and the growth rate of urbanization, just like the name of Bakker’s book: “Growing Cities, Growing Food”, although it is really hard to realize such a dream.
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Introduction
The term “food security” has leapt dramatically to prominence in Australian public discussion since the 2007-8 world food crisis. This paper examines the content of this public discussion, and its possible implications for Australian agricultural policy. Through analysis of articles mentioning “food security” in three major Australian newspapers over the period 1991 to 2010, I explore the thematic development of the discussion, and its intersections with existing neoliberal and productivist policy discourses, as well as more recent multifunctionality and food systems perspectives. The key research question addressed is whether this heightened level of discussion is suggestive of new directions emerging in Australia’s agriculture policy.

Literature review
Agricultural policy in Australia has been following a consistent trajectory of deregulation since the mid-1970s (part of a wider embrace of neoliberal economic policy). Australia has now long had one of the least protected agricultural sectors amongst industrialised nations (Dibden, Potter, & Cocklin 2009). Agricultural policy in Australia can also be described as “productivist”, where productivism “refers to a mode of both agricultural policy and practice that is input intensive and where emphasis is placed on the maximisation of the production of commodities” (Bjørkhaug & Richards 2008, p. 99).

Concern about the social and environment impacts of productivist agriculture has lead in Europe to a policy shift which recognises in addition to their production role the natural resource management and social and cultural maintenance functions of farms. This has
been described as a “post-productivist” or “multifunctional” transition in agricultural policy (Argent 2002, p. 99; Bjørkhaug & Richards 2008, p. 100). Governments in Australia have also recognised farmers’ role as natural resource managers, and this have been examined by scholars as possible evidence of a transition in Australian agricultural policy, however Bjørkhaug and Richards (2008, p.109) conclude that “agricultural multifunctionality in Australia rates weakly as an ideology or policy, and even less as a discourse or practice”.

A more recent shift in agricultural policy discourse emerging in Europe positions agricultural production as but one component of the food system (Lang, Barling, & Caraher 2001) and food system approaches have also recently emerged in Australia (Larsen, Ryan, & Abraham, 2008; Campbell, 2009).

**Method**

I used the media search tool *Factiva* (Dow Jones & Company 2010) to search for the phrase “food security” in three major Australian newspapers11 over the period 19/1/1991 to 8/10/2010. I identified 506 articles, which I coded for content based on four categories: Food security for who? What influences (boosts or threatens) food security? What policy responses are suggested? And which stakeholder voices are represented?

**Results**

The frequency of occurrence of the phrase “food security” in the three publications is shown in Figure 1, and shows a dramatic increase in occurrence in 2008, coinciding with the world food crisis. By mid-2008 the world food crisis had been overshadowed

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as a news story by the global financial crisis, however frequent media references to “food security” have continued\(^\text{12}\). This indicates that food security has established a currency in Australian public discourse that extends beyond the circumstances of the 2008 crisis.

\textbf{Figure 1: Number of articles containing the phrase “food security” by year and source, 1991 \textendash{} 2010\(^\text{13}\).}

While in academic discourse the definition and nature of food security has been carefully analysed and debated, in Australian media usage it is largely left undefined, and in most articles refers simply to the physical availability of sufficient food for a population of interest. The population focus of the articles is summarised in Figure 2.

\(^{12}\) The graphed figure for 2010 includes stories up to 8/10/10. Corrected to include the full year the total figure for 2010 is over 150, well in excess of the 2008 figure.

\(^{13}\) \textit{Factiva} coverage of each publication commences as follows: \textit{The Age} on 19/1/1991, \textit{The Australian} on 8/7/1996 and \textit{The Weekly Times} on 13/8/1997.
Food security for Australia is discussed very rarely up to the end of 2001, but then in the period 2002 to 2007, 20% of the articles talk about food security for Australia, and then the proportion of the articles that refer to food security for Australia has increased every year since. In terms of gross national food supply it is difficult to argue that Australia's food security is at risk, but that has not stopped “national food security” from becoming an established issue of public concern. National food security appeared explicitly as an issue in Australia's 2010 federal election campaign.

The media discussion clearly documents the emergence of a new awareness about constraints to the global food supply. Pressures including increasing population and affluence, resource limitations (land, water, nutrients, energy), declining research and development investment, bio-fuels and climate change are all discussed. There is a clear shift that takes place during this period from (mid-90s) a general optimism about world’s future food security.
situation to, from 2007 on, a clear awareness of the pressures and constraints. This changed awareness is also reflected in reporting of the strategies being adopted by other countries to secure their future food supply, through for example purchasing foreign farmland and fertiliser resources.

Concerning agriculture policy, however, most of the discussion is occurring within the established productivist agricultural and neoliberal economic policy discourses, according to which food security is equated directly with increasing the production of agricultural commodities, through the application of modern technology within a neoliberal domestic and global policy regime. Within this policy discourse “food security” in many cases serves as a buzz-word – an emotive proxy for the self-interest of particular stakeholders. However the discussion also identifies some disquiet with the existing policy trajectory, including overt calls for a reappraisal. New policy trajectories taking a food system perspective are mentioned, as is resistance too them.

**Conclusion**

The 2008 world food crisis has stimulated public discussion in Australia about food security – globally and for Australia. However analysis of print media articles indicates that this discussion is framed mostly within the existing neoliberal, productivist policy discourse. A relatively closed policy community has maintained a policy consensus for several decades, and any departure from this trajectory would require some opening of this policy community to additional influences. Food system perspectives may be one source of such influence.

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Michael Santhanam-Martin
“Food security” and Australian agricultural policy: buzz-phrase or game change?


Entrepreneurial opportunities

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Introduction
Entrepreneurial opportunities are opportunities to bring into existence new goods, services, raw materials, and organizing methods that allow outputs to be sold at more than their cost of production (Casson, 1982). These opportunities exist because different people possess different information (Kirzner, 1997). Most research on entrepreneurship, however, investigates the entrepreneurial process after opportunities have been discovered (Fiet, 1996). Researchers typically adopt this approach because they draw on neoclassical economics or psychological theories that assume people will discover opportunities that are uncorrelated with the attributes of the discoverers (Evans and Jovanovic, 1989), and therefore the process before opportunity recognition is not interesting. Austrian economics challenges the validity of neoclassical economics, arguing that different people will discover different opportunities in a given technological change because they possess different prior knowledge (Venkataraman, 1997). My thesis research will focus on opportunity recognition and the correlation with the attributes (prior knowledge) of the entrepreneur. Therefore I constructed the following research question:

Does prior knowledge influence who discovers entrepreneurial opportunities?

Previous research
Incomplete information means that in any market transcription, people must guess each other’s beliefs about many things (Kirzner, 1973). Because these guesses can be incorrect, this process sometimes leads to errors that misallocate resources. The entrepreneurial process occurs when someone, alert to this misallocation, recognizes that resources are not being put to their
“best use,” obtains the resources, recombines them, and sells them at more than their cost to obtain and recombine them (Casson, 1982). Not everyone recognizes these opportunities because if they did, the resource owner would immediately execute the opportunity and it would not exist. Therefore, it can be proposed that all individuals are not equally likely to recognize a given entrepreneurial opportunity.

Equilibrium theories model market economies in a state in which participants have no incentive to change their present actions, as they are satisfied with the current combination of prices and quantities that are bought or sold (Pearce, 1992). As most of the previous research focusses on this equilibrium perspective, Eckhardt and Shane (2003) assume that equilibrium is either never fully realized in market economies (Kirzner, 1973), or is intermittently disrupted by the profit-seeking actions of individuals (Schumpeter, 1934). Thus, in contrast to the equilibrium theories, which assume away from the existence of entrepreneurial opportunities, Shane (2000) views entrepreneurship as requiring those opportunities. This assumes opportunities can be discovered without actively searching for them through a disequilibrium.

Stiglitz (1994), on the other hand, argues that opportunity discovery depends on relative differences in search costs among potential entrepreneurs. This search model assumes that people know the outcomes for which they are searching and search when the benefit of the information outweighs the cost of obtaining it (Stigler, 1994). Several entrepreneurship researches now argue that people discover opportunities because their superior information processing ability, search techniques, or scanning behavior make them more likely than other people to discover opportunities (Shaver & Scott, 1991). This suggest that people do not discover entrepreneurial opportunities through actively searching for them, but through recognition of the value of new information that they happen to receive through other means. Therefore it can be proposed that people can and will discover entrepreneurial opportunities without actively searching for them.
Methodology
Opportunities do not appear in a prepackaged form (Venkataraman, 1997). This statement underlines the importance of the context of the research and the processes being enacted. Therefore, research will be done through an in-depth field study using case studies. This enables me to investigate prior knowledge on entrepreneurial opportunity recognition within its real life context using multiple sources of evidence.

I will conduct multiple case studies to establish whether the findings of one case also occur in other cases and, as a consequence, the need to generalize the findings. I will triangulate the data through documentary analysis.

Relevance to conference theme
Considering Kirzner’s (1973) statement someone who is alert to misallocation recognizes that resources are not being put to their “best use” will recombine them and sell them at more than their cost to obtain them. Exactly this is what can happen in the food production industry. We know the facts, for instance we will need to grow 50% more food using, at best, the same amount of land. We will have to increase crop yield substantially and deliver this using less fertilizers, less water, and less energy. These facts show us that the food production industry, at the moment, is not putting their resources to their “best use”.

For instance, Biologist Ronald Osinga from the Wageningen University came up with the idea to create enormous beds of sea lettuce which will combat acidification of the sea. Besides that, when linking the sea lettuce to fish farming there will be a closed cycle of nutrient. The waste of fish farming will be used as food for the sea lettuce and the lettuce will be usable as food source. Ronald Osinga’s approach is one of the many solutions for the food production problem. There are many more ideas and many more ideas that will come. The question is, who will act on it. This is where my research can help. My research will give results about
who will be likely to recognize and execute these kind of opportunities.

**Conclusion and possible results**
The identification of opportunities has been recognized as one of the most important abilities of successful entrepreneurs (Ardichvili et al 2003). My thesis will show the influence of prior knowledge on the identification of opportunities. It will show if the kind of knowledge and experience an entrepreneur has will influence the opportunities someone sees. Prior research on the same topic, only focused on the technology industry, has shown someone’s prior knowledge does influences his or her discovery of opportunities. When the outcomes of my research will be positive, it can have important implications for the food production industry. Prior research has provided numerous historical examples in which inventors failed to recognize the commercial value of their inventions. My research can show that before an idea or any change can influence output, an individual must perceive an entrepreneurial opportunity. Because not all entrepreneurs will perceive the same opportunities, some desirable entrepreneurial opportunities may go unnoticed and unexploited. My research outcomes can help the right potential entrepreneurs to get on the right track, which will hopefully result in less unexploited good idea’s to tackle the food production problems.

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