chips
a look at what's new in potato information and technology
Potatoes NEW ZEALAND Growing together
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The nutritional value of potatoes

Potatoes are the third most important food crop for humans after rice and wheat, and worldwide there is a trend towards increasing consumption of potato products. So it is hardly surprising that there has recently been an increase in research investigating the nutritional composition of potatoes. The first paper profiled in this feature article (*Camire et al.*) is a review of the nutrient and bioactive compounds in potatoes and their impact on human health. The paper confirms that potatoes are a good source of dietary fibre, vitamin C, several B vitamins and potassium.

Some research has focused on the starch component, and particularly on the effects of cooking and cooling on starch. For example, in the second paper (*Monro et al*.), rapidly digestible, slowly digestible and resistant starches were measured in nine New Zealand supermarket potatoes and 37 lines from a potato breeding programme. Measurements made immediately after cooking and again after cooling the cooked potatoes indicated that there were significant differences between cultivars, and there was good potential in selecting for the nutritionally beneficial traits, slowly digestible and resistant starch. The glycemic response is another starch-related parameter that was investigated in the third paper (*Lightowler & Henry*). In general, potatoes have a high glycemic index and there are health benefits in reducing this value. The research showed that adding high-viscosity hydroxypropylmethylcellulose, a modified cellulose dietary fibre used extensively in the food industry, to mashed potato lowered the glycemic response.

Even more topical than starch, however, is the concentration of antioxidant compounds in potatoes, particularly those that contribute colour to the tuber. The fourth paper (*Wegener et al.)* demonstrated that including purple-fleshed potatoes in breeding programmes increased anthocyanin and phenol levels of the progeny, but did not have major effects on other parameters, such as dry matter, starch, crude protein and reducing sugars. Measurements of 15 red and purple-fleshed potato cultivars presented in the fifth paper (*Lachman et al*.) showed that there was a very wide range in the concentration of total anthocyanins between the cultivars. In addition, there were major differences in the individual anthocyanidins; for example, 'Highland Burgundy Red' had a high proportion of pelargonidin, while 'British Columbia Blue' almost exclusively contained cyanidin. Compounds found in variable amounts in other cultivars included malvidin, peonidin and petunidin. Levels of total anthocyanins were also related to the height above sea level, annual precipitation and annual average temperature of the sites where the cultivars were grown.

Water stress has been shown to affect antioxidant levels in two recently published studies. In the sixth paper, *Andre et al.* investigated five native Andean cultivars and showed that they responded differently to drought. For example, anthocyanins and other polyphenols decreased drastically in red- (`Sullu') and purple-fleshed (`Guincho Negra') cultivars, but increased in 'Huata Colorada', a purple-skinned and yellow-fleshed cultivar. For most cultivars, carotenoid and vitamin C contents were not affected by drought. The seventh paper, written by the same research group, investigated the molecular mechanisms underlying these drought responses. The expression of 13 genes involved in the biosynthesis of polyphenols was studied and shown to be drought-induced, cultivar-specific and potentially regulated by alterations in sucrose flux.

The carbon footprints of food crop production

Farm survey data from the east of Scotland and published estimates of emissions for individual farm operations were used to determine the carbon footprint of different crops (including potatoes) and farming practices (conventional, integrated and organic). Nitrogen fertiliser produced 75% of the total emissions, and once this was accounted for there were no major differences between farming practices.
Hillier et al. (2009) International Journal of Agricultural Sustainability 7: 107–118.

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Fertigation

During an international symposium on irrigation of horticultural crops held in Australia, Battilani et al. gave three papers relating to fertigation of potatoes. Much of this work has been carried out under an EU project called FertOrgaNic. These papers have now been published and are summarised here. The first paper looked at the nitrogen use efficiency of dynamic (water and nutrient supplies determined from daily calculations of crop growth) and static (fertigation based on expected crop yield with fixed root parameters) fertigation compared to control treatments. Although the dynamic treatment gave higher total dry matter yield per kg nitrogen applied than the static treatment, these treatments did not differ when the calculation was made for marketable dry matter yield. The study also investigated the relative partitioning of nitrogen in leaves, stems and tubers. In the second paper, data were presented that described the root growth of potatoes in trials from five experimental stations representing most of the potato growing soil and climatic conditions in Europe. This information is important for optimising crop water and nutrient management and reducing nutrient leaching losses, and will be used in decision support system for potato crops. The third paper discussed water use efficiency, dry matter accumulation and dry matter partitioning under the static and dynamic treatments described above. These data, collected from six field trials over 3 years, will be used to develop fertigation strategies for different sites and climatic conditions.

Nitrogen uptake and nitrogen use efficiency of fertigated potatoes. *Battilani et al. (2008) Acta Horticulturae 792: 61–67.*

Root development model for potato management. *Battilani et al. (2008) Acta Horticulturae 792: 69–75.*

Water use efficiency and dry matter accumulation in fertigated potatoes. *Battilani et al. (2008) Acta Horticulturae 792: 77–84.*

Selecting improved potato varieties

▶ **Improving the screening process for the selection of potato breeding lines with enhanced polyphenolics content.** This paper describes a simple infrared spectroscopic protocol that allows simultaneous rapid quantification of a range of chemical components in potato tubers, including phenols, anthocyanins and antioxidant capacity. The methodology has good potential for application in potato breeding programmes. *Shiroma-Kian et al. (2008) Journal of Agricultural and Food Chemistry 56: 9835–9842.*

▶ **Molecular dissection of sensory traits in the potato tuber.** This paper describes how the carotenoid content, which influences tuber colour, could be improved by up to six-fold through the transgenic expression of one of three genes. One gene in particular allowed the accumulation of beta-carotene, which is not normally found in potato tubers. Other studies on potato flavour investigated differences between conventional (*Solanum tuberosum* spp. *tuberosum*) and 'Phureja' tubers. There were consistently higher levels of the major umami compounds in 'Phureja' tubers. *Morris et al. (2008) American Journal of Potato Research 85: 286–297.*

▶ **Marker assisted selection of potato clones that process with light chip color.** The current method for determining the chip colour of new potato selection lines involves laboratory tests of tubers from several storage environments over multiple crop seasons. This paper discusses a genetic test for variations in a sucrose synthase allele that may be associated with chip colour. This would rapidly and accurately identify selection lines with the desired characteristics. *Kawchuk et al. (2008) American Journal of Potato Research 85: 227–231.*

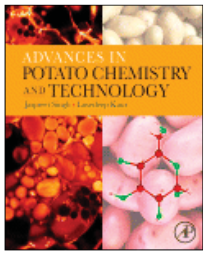
Plant growth regulators

▶ **Yield and quality of early potato cultivars in relation to the use of glufosinate-ammonium as desiccant.** The desiccant glufosinate-ammonium was tested in Italy over 2 years, which differed considerably in climatic conditions. In both years there was no effect of the treatment on yield, but there was an increase in the percentage of tubers in the 35–70 mm diameter range. In one of the 2 years the treatment had negative effects on some qualitative parameters, such as decreased dry matter and vitamin C content, and increased free sugar concentrations. *Gonnella et al. (2009) Journal of the Science of Food and Agriculture 89: 855–860.*

▶ **Tuber quality and nutritional components of 'early' potato subjected to chemical haulm desiccation.** Subsequent research from the same group that published the previous paper has shown that desiccation of three potato varieties ('Spunta', 'Ditta', and 'Krone') with glufosinate-ammonium in southern Italy did not affect levels of total soluble carbohydrates, vitamin C or other antioxidants. However, glufosinate-ammonium treatment did decrease starch storage and increased the percentage of resistant starch. *Buono et al. (2009) Journal of Food Composition and Analysis 22: 556–562.*

▶ **Effects of three plant growth regulators on yield and quality of potato.** Three plant growth regulators (DTA-6 (aminoethyl hexanoate) at 100 mg/kg, uniconazole at 50 mg/kg and superoxide dismutase mimic (SODm) at 100 mg/kg) were sprayed at flower bud appearance on 'Belgium' potatoes grown in field plots in China. Tuber yield was increased by DTA-6 and uniconazole, while uniconazole and SODm enhanced starch and ascorbic acid but decreased reducing sugar content. Phenol content was increased by DTA-6 and SODm but reduced by uniconazole. *Gong et al. (2008) Chinese Potato Journal 22: 73–76.*

▶ **Effects of synthetic phenylurea and nitroguanidine cytokinins on dormancy break and sprout growth in Russet Burbank minitubers.** Minitubers often have a more protracted dormant period than field-grown seed tubers. This study investigated a range of treatments to stimulate sprouting in minitubers and improve plant establishment. Two synthetic cytokinins, N-(2-chloro-4-pyridyl)-N-phenylurea (CP) and 1-(alpha-ethylbenzyl)-3-nitroguanidine (NG), effectively terminated tuber dormancy, but thidiazoyl-urea did not stimulate sprouting. CP and NG were more effective than the naturally occurring cytokinin zeatin, and gave better sprouts than treatment with gibberellic acid. *Suttle (2008) American Journal of Potato Research 85: 121–128.*



New Book

▶**Advances in Potato Chemistry and Technology.** This 528-page, hard cover book is relevant to researchers, academics and graduate students working in food chemistry, agronomy, genetics, horticulture and nutrition. It contains highly detailed information on the chemical composition of potatoes, particularly in relation to starch, along with descriptions of methods for determining the quality of potatoes and their products. The book contains chapters on the effects of cooking and processing potatoes as well as looking towards novel, non-food applications for potatoes, such as biomedical, pharmaceutical and fermentation. *Edited by Jaspreet Singh and Lovedeep Kaur, Riddet Institute, Massey University, New Zealand. Published by Elsevier/Academic Press, June 2009.*

Potato country

▶ **Late blight pathogen can survive in seed tubers during long-term storage.** A recent study has shown that *Phytophthora infestans,* the late blight pathogen, can survive for extended periods of cold storage without expressing any visual symptoms. Once the infected tubers are restored to warmer conditions the latent infection can become apparent, but in the meantime the disease may have been spread to uninfected tubers and introduced into the planting site. Growers need to be aware of this possibility and manage their tubers accordingly. *May/June 2009.*

▶ **Research aims to give consumers richly colored specialty potatoes.** This article describes a University of Idaho research programme that aims to enhance the visual appeal of potatoes and is focusing on developing a set of recommendations for enhancing skin quality. The research investigates a number of issues, including wound-healing, silver scurf disease and harvesting practices along with trials of new varieties that have different skin colours. *July/August 2009.*

▶**UC Davis researchers to look at agricultural nitrogen's impact.** New grants totalling $US2.8 million will be used to develop new methods to measure pollution from agricultural nitrogen fertiliser, including greenhouse gas emissions and nitrogen leachate. These measurements will be important when introducing technologies that are already available and have been developed to reduce these emissions. *July/August 2009.*

▶**Making strides in zebra chip research .** The article summarises the emergence of zebra chip disease in Mexico and North America and the subsequent association of the disease with the potato psyllid insect vector. The actual pathogenic bacterium was discovered in 2008 by two independent research groups in New Zealand and California who named it *Candidatus* Liberibacter solanacearum and *Candidatus* Liberibacter psyllaurous respectively. Ongoing work at the University of Washington by Joe Munyaneza is investigating how the potato psyllid acquires and transmits the bacterium as well as studying the development of the disease in plants and plant susceptibility. Preliminary work indicates that all varieties commonly grown in the Pacific Northwest are susceptible to the disease. Other results show that late infection with the pathogen may not result in disease symptoms, while there appears to be very little transmission of disease symptoms from infected seed tubers. *September/October 2009.* ▶▶

▶**Chemical update: BayerCrop Science's Luna™ and Movento™ look promising in Idaho trials.** Luna™ is a fungicide that will give protection against early blight, brown spot, white mould and other common potato diseases. The active ingredient in Luna comes from a new chemical class known as the pyramides and is characterised as having a 'medium' risk of resistance developing. Movento™ is currently registered as an aphicide but will be introduced in mixes with other insecticides to give broad-spectrum control of many sucking insects. It contains a unique active ingredient from one of the newer chemical classes, tetramic acids, and is expected to have 14–21 days of residual activity. *September/October 2009.*

▶**Chemical update: Voliam Xpress® insecticide receives label expansion to include potatoes, tree fruit and tree nuts.** Syngenta Crop Protection's product contains two active ingredients, chlorantraniliprole and lambda-cyhalothrin, to protect against chewing and sucking insects. The label expansion was recently approved by the Environmental Protection Agency. *September/October 2009.*

Snippets from www.potatonews.com

Listed below is a small selection of the articles that are posted on the Global Potato News website. Please visit the site for further details or follow the links indicated.

▶ **United Kingdom: British potato growers and nutritionists unite to push the health credentials of potatoes.** The British Potato Council has launched a 'Love Potatoes' campaign focused on labelling potatoes as a 'supercarb' – a carbohydrate with all the benefits of a vegetable. The programme aims to boost potato consumption, particularly among young people, and is fronted by a farmer, a cook and TV presenter, and a nutritionist. Market research had shown many consumers were unaware of basic facts about potatoes, such as a jacket potato has more vitamin C than a medium-sized apple or a portion of carrots. The campaign will promote other basic nutritional information about potatoes, including that a jacket potato contains more vitamin B1 than a portion of broccoli and more fibre than an orange. *November 2009, News Headline.*

▶ **US spud industry re-examines GM varieties.** The US National Potato Council is putting together a task force to determine the best way to handle the reintroduction of genetically modified spuds into the marketplace. At least four companies are working on genetically modified potato varieties with traits that range from protection against insects and disease to improving nutritional value. Although no GM potato varieties have yet been submitted to the USDA for formal regulatory approval, the industry wishes to ensure that when they are available the new GM varieties will be accepted by processors and major export markets. *November 2009, Potato Trends.*

Potato store management for energy. At the Potatoes in Practice 2009 conference in the UK, Rod McGovern, crop storage consultant, delivered a presentation on energy efficiency in potato stores. This is an excellent checklist that outlines 12 steps to energy efficiency and covers points that growers should address for all of these steps. It also summarises key points for ambient and refrigerated stores and looked at future developments, including the effects of proposed feed-in tariffs for small-scale renewable energy plants (wind, hydro and solar-electrical). The presentation is available at www.potato.org.uk/media_files/events/pip09_potato_store_mgmt_for_energy_efficiency.pdf. *November 2009, Feature Article.*

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▶ **Potatoes and human health.** *Camire et al. (2009) Critical Reviews in Food Science and Nutrition 49: 823–840.*

▶ **Potato genotype differences in nutritionally distinct starch fractions after cooking, and cooking plus storing cool.** *Monro et al. (2009) Journal of Food Composition and Analysis 22: 539–545.*

▶ **Glycemic response of mashed potato containing high-viscocity hydroxypropylmethylcellulose.** *Lightowler & Henry (2009) Nutrition Research 29: 551–557.*

▶ **Special quality traits of coloured potato breeding clones: Anthocyanins, soluble phenols and antioxidant capacity**. *Wegener et al. (2009) Journal of the Science of Food and Agriculture 89: 206–215.*

▶ **Cultivar differences of total anthocyanins and anthocyanidins in red and purple-fleshed potatoes and their relation to antioxidant activity.** *Lachman et al. (2009) Food Chemistry 114: 836–843.*

▶ **Modification of the health-promoting value of potato tubers field grown under drought stress: emphasis on dietary antioxidant and glycoalkaloid contents in five native Andean cultivars (*Solanum tuberosum* L.).** *Andre et al. (2009) Journal of Agricultural and Food Chemistry 57: 599–609.*

▶ **Gene expression changes related to the production of phenolic compounds in potato tubers grown under drought stress.** *Andre et al. (2009) Phytochemistry 70: 1107–1116.*

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