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Grain Science Transforming our Future

68th Australasian Grain Science Conference

10 -13 September 2018

Charles Sturt University,

Wagga Wagga, NSW, Australia

PO Box 273, Narrabri, NSW, 2390, Australia

Contents

Conference Committees

Organising Committee

Chris Blanchard (Co-Chair)	Charles Sturt University
Asgar Farahnaky (Co-Chair)	Charles Sturt University
Troy Adriansz	DPIRD WA
Joe Panozzo	DPI of Victoria
Vito Butardo	Swinburne University of Technology
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Chris Blanchard	Ex-officio Member	Charles Sturt University

Welcome from the Conference Chairs

It gives us great pleasure to welcome you to Wagga Wagga for the 2018 AGSA conference. Wagga Wagga is an obvious destination for the AGSA conference due to its long history as a centre for grain quality research and education. Agriculture research began in Wagga in the late 1800s and there has been a long association with wheat breeding since then. Nathan Cobb planted the first wheat trials in Wagga Wagga 125 years ago in collaboration with William Farrer. Farrer later relocated to Wagga Wagga and ultimately transformed the wheat industry through the development of adapted varieties with improved baking quality. Farrer's collaboration with Frederick Guthrie who developed small scale tests to assess the quality of new varieties marked the birth of the grain quality discipline in Australia. Farrer's legacy lives on in Wagga Wagga in two important institutions: A Pub (The William Farrer Hotel) and an AFL Football competition (The Farrer Football League).

There has also been a long history of Agricultural education in Wagga Wagga that began with the establishment of an experimental Farm School in the late 1890s at the NSWDPI site. The education focus continued later through the Agricultural College that was opened in 1949. The Ag College later merged with the Teachers College and after further expansions and mergers became a part of Charles Sturt University (CSU).

Grain quality research and breeding continues to be an important focus in Wagga Wagga. The University and NSWDPI have played import roles in collaborative research partnerships such as the Rice and Wheat themed CRCs. More recently Wagga Wagga has been the home of the ARC ITTC for Functional Grains that continues the tradition of undertaking research aimed at adding value to grain. CSU's membership of the Food Agility CRC also continues the tradition of collaborative food science research. Wagga Wagga is still recognised as an important centre for plant breeding and hosts nodes of private breeding companies such as Australian Grain Technologies and DuPont Pioneer. These companies continue the long tradition of the public breeding programs that were based at the Wagga Wagga Agricultural Institute.

Please enjoy your time in Wagga Wagga and we hope you will visit us again.

Prof. Chris Blanchard and Dr Asgar Farahnaky

Welcome from the AGSA Chair

It is my pleasure on behalf of the Australasian Grains Science Association Council to welcome you to this year's conference.

The conference Chairs, Professor Chris Blanchard and Dr Asgar Farahnaky and their hard-working team have put together an excellent program addressing the conference theme of "Grain Science Transforming our Future." This year's conference builds on our mandate to communicate science and innovation to grains industry and the wider audience.

My records indicate this is the third time in the history of AGSA, and the former RACI-CCD, that we've held our annual conference in Wagga Wagga. The first time was in 1967, and again in 2009. Conferences held in rural areas are always well attended and this conference is no exception. Holding the conference at Charles Sturt University allows for a greater number of local students to attend and for students from other universities, there was the opportunity to apply for one of AGSA's travel awards.

I'd like to congratulate the students who have received AGSA travel awards and at this year's conference we will also present the AB Blakeney Early Career Development Scholarship valued at $5000. The award allows the recipient to attend an international conference and develop contacts that will enhance their career.

I hope you enjoy the relaxed conference environment and you have an opportunity to challenge or stimulate new ideas that will be rewarding to you and the organisation you represent.

Joe Panozzo
Chairman AGSA

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68th Australasian Grain Science Association Conference Program

Monday September 10

9.00 – 5.00 pm Early Career Researcher Presentation Workshop, Room 109, Building 288 CSU Wagga Wagga Campus

5.00 – 7.00 pm Conference Registration, CSU Convention Centre

6.00 – 9.00 pm Welcome Reception, CSU Convention Centre

Tuesday September 11

8:30 am - 9:00 am Welcome tea and coffee

Session 1 Tuesday: Investing in Grain Quality Research. Chair: Chris Blanchard. Room A.

9:00-9:05	1.1	C. Blanchard and A. Farahnaky	Welcome from conference co-chairs
9:05-9:10	1.2	Local Elder	Welcome to country
9:10-9:15	1.3	J. Panozzo	Conference opening
9:15-9:35	1.4	S. Thomas	GRDC investment in grain quality research
9:35-9:55	1.5	T. Coram	Private sector investment in grain quality research (breeding)
9:55-10:15	1.6	P. Wilson	Private sector investment in grain quality research (processing)
10:15-10:30	1.7	C. Blanchard	ARC investment in grain quality through the ARC ITTC for Functional Grains

10:30 am – 11:00 am Morning tea

Session 2A Tuesday: LMA. Chair: GRDC. Room A.

11:00-11:10	2A.1	H. Robertson	LMA: Setting the scene
11:10-11:35	2A.2	A.P. Callcott and D.J. Mares	Genetic and temperature control of late-maturity α-amylase (LMA) expression in wheat
11:35-12:00	2A.3	M. Newberry, A. Zwart, A. Whan, J.C. Mieog, N. Daneri-Castro, J. Pritchard, D. Diepeveen, C. Howitt and J-P. F Ral	Late maturity alpha-amylase, falling number, baking quality: what do we know?
12:00-12:10	2A.4	R. Williams	LMA field trial program
12:10-12:30	2A.5	H. Robertson (facilitator)	Panel Session

Session 2B Tuesday: Rice 1. Chair: Michelle Toutounji. Room B.

11:00-11:30	2B.1	R. Anacleto, G. Misra, S. Parween, M. Krishna de Guzman, S. Badoni, V. Butardo and N. Sreenivasulu	Nutrigenomics implications in rice for translated health benefits of consumers to tackle the double burden global challenges
11:30-11:45	2B.2	J. Smith	AgriFutures investment in rice quality
11:45-12:00	2B.3	F. Ali, D. Waters, B. Ovenden, P. Bundock, C. Raymond, T. Kretzschmar and T.J. Rose	Impact of temperature stress during late grain filling on head rice yield
12:00-12:15	2B.4	R.M. Wood, A.J. Mawson, D.L.E Waters, C.L. Blanchard, B.W. Dunn and P. Oli	Vegetative water stress alters grain-filling behaviour improving grain quality in rice
12:15-12:30	2B.5	S. Rao, A. B. Santhakumar, K.A. Chinkwo and C.L. Blanchard	Potential health benefits of rice phenolic compounds

12:30 pm – 1:30 pm Lunch and Tour of NSWDPI/CSU laboratories

Session 3 Tuesday: Grains and Gut Health. Chair: Anne Bridges. Room A.

1:30-1:50	3.1	J. Muir	How does the gluten-free and low FODMAP diets affect grain consumption?
1:50-2:10	3.2	I. Brownlee	Whole grains, grain fibre and "normal" gut function
2:10-2:30	3.3	Sara Grafenauer and F. Curtain	A whole lot of whole grain – evidence for health, consumption and the code of practice
2:30-3:00	3.4	M.J. Gidley	Grain dietary fibres have diverse mechanisms of nutritional action

3.00 pm – 3:30 pm Afternoon tea

Session 4A Tuesday: Healthy Grains. Chair: Mahsa Majzoobi. Room A.

3:30-4:00	4A.1	N. Larsen, S. Roberts, C. Munro and R. Craigie	A first look at whether or not N-fertiliser applications affect coeliac epitope levels in New Zealand wheats
4:00 -4:15	4A.2	C. Florides, F. Bekes , W. Ma, T. Vanniasinkam, R. Eastwood, C. Blanchard and A. Juhasz	Developing a molecular diagnostic tool for wheat breeders to help in predicting wheat varieties with reduced gluten intolerance
4:15-4:30	4A.3	L. Emebiri and K. Taylor	Free amino acids in wheat grains are potential targets for breeding healthy foods
4:30-4:45	4A.4	H. Li, S. Dhital, A.J. Slade and M.J. Gidley	High amylose wheat: a novel cereal to bridge the 'fibre gap'
4:45-5:00	4A.5	X. Jiang, Z. Hu, H. Zhang, X. Tan, P. Zhang, H. Gan, M.A. Sullivan, B. Deng, E. Li, R.G. Gilbert and C. Li	The effects of carbohydrate-restrictive diets on glycogen molecular structure and implications for diabetes management

Session 4B Tuesday: Rice 2. Chair: Rachael Wood. Room B.

3:30-3:45	4B.1	H. Stokoe	Quality trends in the rice industry
3:45-4:00	4B.2	N. Saji, A. B Santhakumar, L. Schwarz, A. Durand and C.L Blanchard	Effect of different stabilization treatments on the fatty acid content, phenolic composition and antioxidant activity of reiziq rice bran
4:00-4:20	4B.3	W. Shang, X. Si, Y. Li, C. Blanchard and Z. Zhou	Preparation of gama-aminobutyric acid-enriched rice bran and its modulation on gut microbiota and cognitive function of rats in high-fat diet
4:20-4:40	4B.4	P. Oli and M. Talbot	Rice quality from breeding and industry perspectives
4:40-5:00	4B.5	E.T. Callcott, A.B. Santhakumar, P. Oli and C.L. Blanchard	Rice-derived polyphenols reduce inflammation and oxidative stress biomarkers in human umbilical vein endothelial cells

6:30pm – late Student Dinner at Thirsty Crow 153 Fitzmaurice St, Wagga Wagga.

6:30pm – late Chairman's dinner and or a free night

Wednesday September 12

8:30 am - 9:00 am Welcome tea and coffee

Session 5A Wednesday: Wheat Quality Genetics. Chair: Annie Riaz. Room A.

9:00-9:30	5A.1	M. Newberry, A. Verbyla, K. Verbyla, R. Appels, D. Diepeveen, L. Cato and C. Howitt	Understanding the genetics of wheat quality using MAGIC populations
9:30-9:45	5A.2	A. Juhász, T. Belova, C. G. Florides, Gy. Gell, Zs. Birinyi, G. Keeble-Gagnère, W. Ma, J. A. Tye-Din, O-A. Olsen and R. Appels	Genome mapping of the prolamin superfamily proteins in wheat facilitates the understanding of their fine-tuned role in storage material accumulation, stress responses and human health
9:45-10:00	5A.3	Y. Zhao, W. Ma, S. Islam, J. Zhang and A. Juhász,	Exploring potential candidate genes and discovering new molecular makers by QTL mapping to improve nitrogen use efficiency for Australian wheat breeding
10:00-10:15	5A.4	Y.J. Zhang, S. Islam, A. Juhasz, X.Y. Chen, Z.H. He, X.Y. Cao, M.Y. She and W.J. Ma	Evolution and function of wheat grain avenin-like protein
10:15-10:30	5A.5	C.W. Wrigley, R. Nirmal, A. Furtado and R.J. Henry	The genetic control of wheat quality: A complex puzzle

Session 5B Wednesday: Starch Digestibility. Chair: Nancy Saji. Room B.

9:00-9:30	5B.1	M. van Leeuwen, G. Barbosa, R. Ward, R. Wuhrer, M. Gaborieau and P. Castignolles	Towards predicting starchy food digestibility: characterisation of starch by capillary electrophoresis, NMR spectroscopy and more!
9:30-9:45	5B.2	W. Zou, J. Luo, V. M. Butardo Jr , A. Farahnaky and C. Blanchard	A high throughput *in vitro* digestibility assay for rapidly predicting glycaemic index of rice varieties
9:45-10:00	5B.3	Y. Bai, A. Sharat, P. Wu, K. Wang, E. Li and R.G. Gilbert	Effects of pectin on digestibility, viscosity and molecular structural changes of starch during *in vitro* digestion process
10:00-10:15	5B.4	M.R. Toutounji, A. Farahnaky, V. Butardo, P. Oli and C. Blanchard	The impact of processing on starch digestibility
10:15-10:30	5B.5	J.J. Lee, J.D. Oliver, C. Blanchard, D. Waters, M. Gaborieau and P. Castignolles	Monitoring *in vitro* digestion of rice starch using capillary electrophoresis online

10:30 am – 11:00 am Morning tea

Session 6A Wednesday: Breeding for Quality. Chair: Chris Florides. Room A.

11:00-11:15	6A.1	A. Rattey, D. Moody, D. Mullan, H. Robinson, T. Walmsley	Importance of targeted end-to-end research in cereal grain quality for industry impact
11:15-11:30	6A.2	L. Emebiri, N. Collins, H. Shirdelmoghanloo, S. Hildebrand, M. Sissons and D. Pleming	Genetic tools to protect wheat from the impact of heat stress
11:30-11:45	6A.3	S. Al-Sheikh Ahmed, J. Zhang, W. Ma and B. Dell	Contributions of TaSUTs to grain weight in wheat under drought
11:45-12:00	6A.4	T. Nguyen, S. Mitra, R. Buswell, M.Tucek, R.G. Gilbert, M.J. Gidley and G. Fox	Effect of genotype, environment and processing on starch molecular structure and some physicochemical properties of oat flour
12:00-12:15	6A.5	N. Sultana, A. Juhasz, S. Islam, M. She, R. Yang and W. Ma	Genetic characterization of TA-NACS gene across Australian wheat cultivars in relation to senescence and thousand kernel weight
12:15-12:30	6A.6	Q. Riaz, C. Florides, F. Békés, A. Farahnaky, D. Pleming, M. Majzoobi, R. Eastwood and C.L. Blanchard	High and low molecular weight glutenin subunit alleles of historic and modern Australian wheat varieties and their effect on dough rheology

Session 6B Wednesday: Sorghum. Chair: Siong Tan. Room B.

11:00 -11:30	6B.1	I.D. Godwin, B. Tabet, G. Liu, Y. Trusov, K. Massel, B. Campbell, A. Cruickshank, E.S. Mace, D.R. Jordan, G. Fox, C. Haire and J.R. Botella	GM and gene edited sorghum with larger grain and higher protein content: glasshouse and field trials
11:30-11:45	6B.2	D. Metcalf and A. Saliba	Opportunities for Australian sorghum: from low value commodity to high value market share
11:45-12:00	6B.3	T.H. Roberts, A. Khoddami, H.T. Kuan, B. Cunio, G.L. Readett and T. Saputra	New applications for Australian sorghum grain in foods and beverages
12:00-12:15	6B.4	S. Tan, A. Khoddami, D. Tan, T. Bishops, T. Roberts, A. Farahnaky, C. Blanchard and J. Mawson	Fermentation performance of current Australian sorghum varieties
12:15-12:30	6B.5	S. Rao, A.B. Santhakumar, K.A. Chinkwo, G. Wu, S.K. Johnson and C.L. Blanchard	Characterization of antioxidant active phenolic compounds in sorghum grains using UHPLC-online ABTS and LC-MS QTOF

12:30 pm – 1:30 pm Lunch and Tour of NSWDPI/CSU laboratories

Session 7A Wednesday: Methods. Chair: Leco. Room A.

1:30-2:00	7A.1	B.V. McCleary, C. McLoughlin and L.H.M. Charmier	Measurement of starch and starch fractions
2:00 - 2:15	7A.2	R.G. Gilbert, H. Li, W. Yu, G. Fox, K. Tao, S. Prakash, S.S Nada and C. Li	New methodology for selecting grains for improved properties
2:15-2:30	7A.3	M. Berra, O. Le Brun and A. Dubat	Testogram, Hagberg Falling Number measurement in 90s
2:30-2:45	7A.4	V.M. Butardo, R. Hocking and D.Paterson	Visualising micronutrient distribution and mobilisation in germinating rice grains
2:45-3:00	7A.5	K.A.F. Gajo, M.L. Bason, Arcot and J.M.C Dang,	Assessing rheological properties of starches and hydrocolloids in high temperature conditions

Session 7B Wednesday: Pulses. Chair: Randy Adjonu. Room B.

1:30-2:00	7B.1	J.F. Panozzo and L. McDonald	Application of high-throughput image analysis to quantify pulse quality traits
2:00-2:15	7B.2	S. Cork, C.L. Blanchard, A.J. Mawson and A. Farahnaky	Production and characterization of ready-to-eat chickpea flakes
2:15-2:30	7B.3	D. Pleming and M. Majzoobi	Improving baking quality of lupin-wheat breads through addition of dried gluten
2:30-2:45	7B.4	D. Portman, C. Blanchard, P. Maharjan, L.S. McDonald, J. Mawson, M. Naiker and J.F. Panozzo	Blending studies using wheat and lentil cotyledon flour – effects on rheology and bread quality
2:45-3:00	7B.5	K. Mazumder, K. Chinkwo, A Farahnaky and P.G. Kerr	The potential of lupin as a functional food for the prevention of diabetes and pancreatic cancer

3.00 pm – 3:30 pm Afternoon tea

3:30 pm - 5:00 pm Annual General Meeting

6:30pm – 11:30 pm Conference Dinner at Magpie's Nest, Cnr Old Narrandera and Pine Gully Road, Wagga Wagga

Thursday September 13

8:30 am - 9:00 am Welcome tea and coffee

Session 9A Thursday: Cereal Processing 1. Chair: Wei Zou. Room A.

9:00-9:30	9A.1	W. Huang	Status and trends for the development of science and industry of cereal-based foods in China
9:30-9:45	9A.2	S. Siah, K. Quail, D. Li, S. Lim, M. Yamamoto, S. Cowman, C. Carter and B. Cox	Opportunity for Australia to supply soft wheat for cake and biscuit applications in Asia
9:45-10:00	9A.3	N. Alzuwaid, M.J. Sissons, C.M. Fellows	Fortification of pasta with wheat bran protein concentrate
10:00-10:15	9A.4	R. Liu, Vi. A. Solah, Y. Wei, G. Wu, X. Wang, G. Crosbie and H. Fenton	Sensory evaluation of Chinese white salted noodles and steamed bread made with Australian and Chinese wheat flour
10:15-10:30	9A.5	F. Saeed and M. Nouman	Distribution of different enzymes in thirteen milling fractions of spring wheats

Session 9B Thursday: Canola Chair: Stephen Cork. Room B.

9:00-9:20	9B.1	B. MacSmith	Research needs for the canola industry
9:20-9:40	9B.2	J. Ayton, K. Graham, T. Potter, R. Mailer and P. Salisbury	The effect of genotype and environment on quality parameters in Australian canola
9:40-10:00	9B.3	S. Tan, A. Farahnaky, L. Day, T. McCann and C. Blanchard	Adding value to canola meal: preparation of high protein meals
10:00-10:15	9B.4	R. Adjonu, J. Ayton, P.D. Prenzler and C.L. Blanchard	Does crude oil extraction technique affect canola oil functionality?
10:15-10:30	9B.5	K. Reynolds, A. El Tahchy, Q. Liu, X.R. Zhou and S. Singh	Increasing seed oil content of *Brassica napus*

10:30 am – 11:00 am Morning tea

Session 10A Thursday: Cereal Processing 2. Chair: James Lee. Room A.

11:00-11:15	10A.1	M. Majzoobi, D. Pleming, M.A. Namavar and A. Farahnaky	Innovative part-baked bread with improved nutritional value
11:15-11:30	10A.2	S. Mitra, R. Buswell, T. Nguyen, G. Fox and M. Tucek	Quality assessment of Australian oat varieties and their performance in processing Asian oat products
11:30-11:45	10A.3	L. Wang, J. Xu, X. Fan and Q. Wang	Characterization of branched limit dextrin and impact on starch retrogradation properties

11:45-12:00	10A.4	Q. Zhang, H. Luo, X. Du, M. Tucek, Y. Ren and C. Li	Understanding protein degradation during malting and mashing to improve barley malt qualities
12:00-12:15	10A.5	H. Bader-Ul-Ain and F. Saeed	Modification of barley dietary fibre through thermal treatments
12:15-12:30	10A.6	A. Ahmed, S. W. Ali, F. Saeed, M. Afzaal and H. Farooq	Characterization and nutritional profiling of potato peel blended composite flour wheat cookies

Session 10B Thursday: Future Trends. Chair: Esther Callcott. Room B.

11:00-11:30	10B.1	A. Saliba	Future trends –the consumer of the future
11:30-11:45	10B.2	K.J. Quail, L. Cato, C. Carter, R. Kingwell, B. Cox, S. Cowman, P. Elliot and S. Siah	Building stronger wheat markets in south east Asia
11:45-12:00	10B.3	K. McKenzie and A. Saliba	Understanding lentil consumers in India: consumer behaviour, likely future demand, and attitudes to Australian lentils
12:00-12:15	10B.4	K. Hester, A. Saliba and E. McIntyre	Uncovering the untold story of gluten avoidance
12:15-12:30	10B.5	P. Meibusch	Future directions in grain quality research

12:30 pm – 1:00 pm Lunch to go

1:00 pm - 4:00 pm Post Conference Tour of Riverina Oil and Bio Energy

List of Posters

P1	H.S. Dhammu, R. Snowball , A. Yousif, D.L. Sharma and T.D. Adriansz	Novel approaches to quinoa saponin removal assessment techniques in Western Australian trials
P2	Tabussam Tufail, Farhan Saeed and Huma Bader Ul Ain	Comparative compositional analysis of different varieties of wheat straw with special reference to bioactive constituents
P3	S. Tan and A. Farahnaky	Characterization of puffed and freeze-dried lupin seeds
P4	A. Dubat, M. Berra and S. Cochet	Creation of a milling performance index (MPI) based on the behaviour of wheat during laboratory milling
P5	Jihui Zhu	Diversity and effect on quality of *Wx* gene in rice
P6	Mahsa Majzoobi, Naveed Aslam and Denise Pleming	Determination of phytic acid content of different varieties of Australian grains
P7	Mahsa Majzoobi, Golsa Karambakhsh, Davood Tabatabaei and Gholam Reza Mesbahi	Effect of oleaster powder as a functional ingredient on batter and cake quality
P8	M. Majzoobi, D. Pleming and N. Aslam	Assessment of lupin-wheat noodles
P9	M. Majzoobi, M.B. K. Aghdam, M.H. Eskandari and A. Farahnaky	Development of symbiotic bread using straight dough and frozen part baking methods
P10	Barry V McCleary and Lucie H.M. Charmier.	A method to measure all types of fructan; inulin, levan and agave (highly branched) fructan
P11	D. Pleming, N. Taber, F. Bennett and M. Majzoobi	Effect of hydrocolloids on rheological behaviour of lupin-wheat doughs
P12	D.J. Skylas, H.Salman and K.J. Quail	Potential variation in the measurement of wet gluten
P13	Muhammad Afzaal and Farhan Saeed	Effect of encapsulation on the viability of probiotic bacteria in cereal based beverage
P14	D.J. Skylas, H. Salman, I. Wesley, S. Lim, S. Urthayakumaran, E. Testa and K.J. Quail	Salt in bread
P15	S.A. Awad	Chemical modification of wheat gluten by using polyvinyl alcohol fibres-glyoxal complex
P16	Keyu Tao, Cheng Li, Wenwen Yu, Robert G. Gilbert and Enpeng Li	How amylose molecular fine structure of rice starch affects pasting and gelatinization properties
P17	W.P. Quek, W.W. Yu, G. Fox and R.G. Gilbert	Effects of barley grain sizes on the mashing performance. How barley grain sizes determine the sugar profile during mashing?
P18	R.M. Wood, J. L. Balindong, A.J. Mawson, D.L.E Waters, C.L. Blanchard, B.W. Dunn and P. Oli	Effect of nitrogen fertiliser rate and timing on grain quality parameters and protein composition of rice grown in south-eastern Australia

P19	A. Pourvali, P. Kerr, D.L.E. Waters, D. Ganesalingam and C.L. Blanchard	Effect of genotype and environment on alkaloid content and composition as measured by GC-MS
P20	E. Morales-Polanco, R. Campos-Vega, M. Gaytán-Martínez and G. Loarca-Piña	Functional and textural properties of a dehulled oat (*Avena sativa* l) and pea (*Pisum sativum*) protein isolate cracker
P21	Saira Hussain, Ata-ur-Rehman, David J. Luckett, Christopher L. Blanchard, Hassan K. Obied and Padraig Strappe	Anti-adipogenic properties of canola meal extracts

1.7

ARC INVESTMENT IN GRAIN QUALITY THROUGH THE ARC ITTC FOR FUNCTIONAL GRAINS

Christopher L. Blanchard

ARC Industrial Transformation Training Centre for Functional Grains, Graham Centre, Charles Sturt University, Wagga Wagga NSW Australia.

Historically, grain quality research has been largely funded by organisations such as GRDC or through public breeding programs such as those that were hosted by state departments. With the disappearance of many public breeding programs after the privatisation of breeding in recent years and GRDC's recent focus on production related research, other models have been required to continue the important work of grain scientists. As private breeding companies increase in size they will have the capacity to invest in grain quality research. However this is likely to be investments in technologies such as defect elimination that will assist in marketing new varieties to growers. Other funding models are required to progress research that enhances the functional properties of grains.

2A.2

GENETIC AND TEMPERATURE CONTROL OF LATE-MATURITY A-AMYLASE (LMA) EXPRESSION IN WHEAT

A.P. Derkx and D.J. Mares

School of Agriculture, Food and Wine, University of Adelaide, Waite Campus, Glen Osmond, SA 5064, Australia

Late-maturity α-amylase (LMA) is a genetic defect in wheat (*Triticum aestivum* L.) involving the production of high pI α-amylase during grain filling and maturation, resulting in grain with an unacceptable low Hagberg Falling Number. LMA expression is under both genetic and environmental control. Several QTL have been identified that are all recessive and additive, with a major locus located on the long arm of chromosome 7B. The existence of genetic repressors of LMA has also been suggested but not as yet confirmed. While tall genotypes will express LMA under a wide range of environmental conditions, genotypes carrying one of the gibberellin-insensitive semi-dwarfing genes such as *Rht-B1b* or *Rht-D1b* show strongest expression when submitted to a cool-temperature shock during a limited window of grain development. The sensitivity of genotypes with and without semi-dwarfing genes to LMA induction via cool-shock during grain development has been characterized in detail. It was also found that rather than cool-shock, cool temperatures *per se* can induce LMA, which if found to be reliable would allow for a simplified LMA screening system.

2A.3

LATE MATURITY ALPHA-AMYLASE, FALLING NUMBER, BAKING QUALITY: WHAT DO WE KNOW?

Marcus Newberry[1], Alec Zwart[2], Alex Whan[1], Jos C Mieog[1], Nicolas Daneri-Castro[1], Jenifer Pritchard[1], Dean Diepeveen[3], Crispin Howitt[1] and Jean-Philippe F Ral[1]

[1] CSIRO Agriculture and Food, GPO Box 1700, Canberra ACT 2601 Australia
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Late maturity α-amylase (LMA) is a recently identified quality issue that is now receiving increasing attention and whose prevalence is now seen as impeding the development of superior quality wheat varieties worldwide.

LMA is a genetic defect present in specific wheat genotypes and is characterized by abnormally elevated levels of the high pI TaAMY1 alpha-amylase, triggered by environmental stress at precise grain developmental stage. TaAMY1 remains present in the aleurone layer throughout grain maturity and harvest. To the exception of the elevated level of alpha-amylase, LMA affected grain does not present any visible detrimental effect on grain morphology, properties or germination. However, elevated level of alpha-amylase lowers Falling Number (FN) test (a test used to detect sprouted grain) at receival, causing a down-grading of the grain, often to feed grade, thus reducing the farmers' income. In Australia, if grains present a low FN (below 300), there is a potential $20-50/t penalty to growers due to discounting superior milling wheat classes to feed grade. In the United States, the Pacific North West was severely affected during the 2016 harvest with losses estimated to be in the order of $US140 millions. This severely impacts grower profitability through increasing risk of a reduced grain value. This downgrading is based on the assumption within the grain industry that a low FN represents poor quality grain. Consequently any wheat line possessing low FN or high alpha-amylase levels is automatically considered a poor bread wheat despite there being no published evidence to date, to show that LMA is detrimental to end product quality.

To evaluate the validity of this assumption we performed a comprehensive evaluation of baking properties from over 200 RILs from Multi-parent Advanced Generation Inter-Cross (MAGIC) wheat population grown at three different sites. The rationale behind the use of tall lines was to take advantage of the high LMA sensitivity of non-Rht background and to overcome the impediment of environmental stress required to trigger LMA.

LMA levels were assessed along with quality parameters including end product functionality such as bread loaf volume and weight, crumb firmness, oven spring, slice area and brightness and gas cell number using AACC Approved Methods 10-09.01 and 10-10.03. No consistent or significant genetic or phenotypic correlation was found between LMA related Falling Number and any of the quality traits. This study provides the first direct evaluation as to whether elevated levels of α-amylase found in LMA impact baking quality.

2B.1

NUTRIGENOMICS IMPLICATIONS IN RICE FOR TRANSLATED HEALTH BENEFITS OF CONSUMERS TO TACKLE THE DOUBLE BURDEN GLOBAL CHALLENGES

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Diabetes and related non-communicable diseases are becoming epidemic in urban regions of Asia, while children and women face undernutrition challenges in the rural community. Assessing the nutritional profiles of modern varieties of rice did not show enough genetic variability for low glycaemic index (GI) and enriched micronutrients. Hence we have employed various phenotyping methods such as slower digestibility techniques and all 12 macro and micronutrient profiling techniques from the gene bank diverse lines. The core panel has been subjected to resequencing and accounted SNP and indel variation has been explored to mine novel alleles for the nutritional traits. These opportunities provide novel opportunities for diet based intervention to counter the growing problems.

However, screening for low glycaemic index (GI) in rice breeding programs is not possible due to time and cost constraints. In this presentation I will be providing overview about the novel methods such as the feasibility of using *in vitro* cooked grain amylolysis, starch mobilization patterns during seed germination, and variation in starch structure and composition in the mature seed to differentiate patterns of starch digestibility. Mobilization patterns of total starch, resistant starch, amylose and amylopectin chains, and free sugars during seed germination revealed that the process is analogous to digestion in the human gastrointestinal tract. The combination of these biochemical markers can be used as an alternative measure to predict GI. Studying contrasting low GI lines with transcriptome analysis of stored mRNA transcripts detected differences in starch metabolism and confirmed the importance of seed storage pathways in influencing digestibility. Pathway analyses supported by metabolomics data revealed that resistant starch, cell wall non-starch polysaccharides and flavonoids potentially contribute to slower digestibility. These new insights can guide precision breeding programs to produce low GI rice with acceptable cooking quality to help mitigate the burden of diet-associated lifestyle diseases.

2B.3

IMPACT OF TEMPERATURE STRESS DURING LATE GRAIN FILLING ON HEAD RICE YIELD

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Global climate change represents a threat to the productivity of staple crops, including rice (*Oryza sativa*). Rice is sensitive to heat stress, but the impact of heat stress during grain filling on rice yields and grain quality traits such as % head rice yield has not been fully resolved. In the present study, we evaluated the impact of increased heat stress events in two *japonica* (Baru, Lemont) and one *indica* rice cultivar (Teqing) along with Californian line M205 (*japonica*) in a controlled environment. A 10 d heat stress event (31/23ºC, 33/24ºC and 35/25ºC: day/night, 12h/12h) was applied to all cultivars from 10 days after 50% flowering/anthesis (DAF) to 20 DAF compared to a control treatment (28/21ºC; day/night for 12h/12h). The percentage head rice yield is determined by the factor of the rice grain cracking during the milling operation. However, the knowledge is limited to the steps involved in milling operations, such as de-hulling and polishing. The present study focused on the rice grain cracking during milling operations, i.e., de-hulling and polishing steps. Interestingly, we observed the losses during de-hulling increased as the severity of heat stress gradually intensified but yield losses during polishing were temperamental. Genotypic variations during de-hulling were significant ($P < 0.05$) and M205 had higher grain cracking percentage as compared to Baru, Teqing, and Lemont. The influential impact of polishing on grain cracking was significantly higher in Teqing followed by M205, Baru, and Lemont. Further, determining the % HRY, the genotype Baru had a higher percentage under control conditions and temperature stress of 31/23ºC and 33/24ºC. While, under the extreme heat stress event (35/25ºC), the genotype had the following order to % HRY; Lemont > Baru > M205 > Teqing. The mean comparison ($P < 0.05$) of genotypes × treatment interaction showed that under heat stress event of 31/23ºC, significant genotypic differences were observed to % HRY. These findings reveal that understudy heat stress event could be employed on the known mapping populations set of Baru × M205 and Lemont × Teqing, to segregate the phenotype (% HRY) for mapping QTLs/genes related to this trait.

2B.4

VEGETATIVE WATER STRESS ALTERS GRAIN-FILLING BEHAVIOUR IMPROVING GRAIN QUALITY IN RICE

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Drought and competition from the environment, cotton and nut crops have seen a reduction in the availability of irrigated water for rice production in south-eastern Australia. The need to maintain yields with less water has led to the development of a water saving technique referred to as delayed permanent water (DPW). Conventional practices have rice permanently flooded throughout most of its life cycle whereas in DPW, the crop is intermittently irrigated during the vegetative stage and permanent water applied until just before the crop reaches the reproductive stage. Removing permanent water post flowering with intermitted irrigation until maturity, known as DPW with post flower flushing (DPW+PFF), can provide further water savings. DPW improves nitrogen and water use efficiency of rice without a substantial reduction in grain yield. Although yield is important in rice production, Australia competes in the global rice market by producing high-quality grain for premium markets with financial penalties applied to growers who do not meet these high-quality standards. Consequently, even with high yields, grower's returns can be negatively impacted by poor grain quality. Currently, the impact of DPW and DPW+PFF on grain quality of rice grown in south-eastern Australia is unknown. We compared the effect of DPW and DPW+PFF with conventional drill irrigation on grain-filling behaviour and quality parameters of two commercial Australian rice varieties (Medium grain varieties Sherpa and Reiziq). These data revealed water stress during the vegetative period (DPW and DPW+PFF) reduces the grain-filling duration. However, extends grain maturation (100% flowering to 18-22% grain moisture) which had a significant positive correlation with whole grain yield (WGY; the proportion of whole grain expressed as a percentage of harvested grain). Furthermore, DPW and DPW+PFF had a significantly higher WGY compared to conventional drill irrigation for both varieties tested. These data indicate that water stress during the vegetative stage influences grain-filling behaviour which improves grain quality.

2B.5

EFFECT OF ENVIRONMENT ON RICE PHENOLIC CONTENT AND ANTIOXIDANT ACTIVITY

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The effect of cultivation environment on phenolic content and respective antioxidant activity was examined in whole grain rice. Rice samples examined included pigmented and non-pigmented varieties from New South Wales (NSW) and Queensland. It was observed that cultivation environment had a substantial impact on rice phenolic content and antioxidant activity. Anthocyanin and proanthocyanidin, the two major bioactive compounds present in pigmented rice (Purple and Yunlu29) also exhibited considerable variation between the two locations. While environment affected various phenolic compounds across the varieties, variation in antioxidant activity was mainly observed in compounds that had high antioxidant activity. Hence, difference of antioxidant activity was more prominent in pigmented Yunlu 29 and Purple compared to Reiziq, the brown rice variety. The study also observed that not every phenolic compound present was affected by environment, some were stable, while others were more susceptible. Some of these susceptible compounds were predominant contributors of antioxidant potential in rice. Therefore, further studies and optimisation of cultivation environment can aid in production of higher quality grains in relation to their end use as functional foods and food ingredients.

3.1

HOW DOES THE GLUTEN-FREE AND LOW FODMAP DIETS AFFECT GRAIN CONSUMPTION?

J.G. Muir

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Grains are an excellent source of dietary fibre and prebiotic carbohydrates (eg. fructans) that can normalise gastrointestinal function and selectively stimulate populations of gut microbiota. However, the consumption of grains has been greatly impacted over the last decade. This has mostly been due to the uptake by the general community of the gluten-free and low FODMAP diets. FODMAP is an acronym that stands for Fermentable Oligo- Di-Mono-saccharides And Polyols. This talk will compare and contrast the gastrointestinal disorders (coeliac disease and irritable bowel syndrome (IBS)) that require the dietary manipulation of grains.

3.2

WHOLE GRAINS, GRAIN FIBRE AND "NORMAL" GUT FUNCTION

Iain Brownlee

CSIRO Nutrition & Health Program.

Despite historical observations linking whole grains and fibre to normal bowel function, there has been more recent research focus on their association with cardiovascular and metabolic health. This talk will outline the evidence base linking intake of whole grain/fibre intake with improved laxation and reduced risk of colorectal cancer and will also highlight some of the challenges in assessing gastrointestinal health.

3.3

A WHOLE LOT OF WHOLE GRAIN – EVIDENCE FOR HEALTH, CONSUMPTION AND THE CODE OF PRACTICE

Sara Grafenauer and F. Curtain

Grains and Legumes Nutrition Council

The 48g whole grain Daily Target Intake (DTI) is based on evidence of a reduced risk of highly prevalent chronic diseases such as heart disease and type 2 diabetes. Grains & Legumes Nutrition Council (GLNC) commissioned triennial research to assess the proportion of adults meeting the whole grain DTI via a nationally representative sample of Australians aged 15-70 years (n=1,221). Participants completed a two-day food record and an attitudinal survey. Median daily whole grain intake was 26g (IQR 4-58g). Only 31% of adults met the 48g DTI, consuming at least three serves of foods that were high in whole grain (16g/serve). This is equivalent to a bowl of whole grain breakfast cereal and a sandwich with whole grain bread. Of those who fell short, 55% consumed less than two serves (<32g), 38% less than one serve (<16g) and 14% were non-consumers. The most common barrier to intake was a preference for refined grain foods. Participants' listed that competitive pricing, clear on-pack labelling and information about health benefits were facilitators of whole grain consumption. This study supports existing research which shows that the majority of Australians are not meeting whole grain recommendations associated with health and reduced chronic disease risk. Clear messaging by food industry about whole grain foods and improved education by healthcare professionals is required to encourage Australians to choose whole grain foods more often. Research based on audits of the food supply and an impact assessment of the Code of Practice for Whole Grain Ingredient Content Claims will also be presented.

3.4

GRAIN DIETARY FIBRES HAVE DIVERSE MECHANISMS OF NUTRITIONAL ACTION

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The physical properties of grain dietary fibre components relevant to digestive tract functionality can be grouped into (i) bulk structuring, (ii) transport barriers, and (iii) molecular binding. Examples of each type of functionality from both in vitro and in vivo studies will be presented. In the digestive tract, these properties manifest themselves in each compartment e.g. gastric digesta structuring related to emptying rate, binding/transport of enzymes in the small intestine limiting digestion rates, and control of fermentation rate in the large intestine. Subsequent health properties are likely to result from the integration of the biological effects of these and many other physico-chemical interactions. Dietary fibre in grains and other foods should not be thought of as just an ingredient, but rather as the food structure factor that influences the nutritional functionality of all components.

4A.1

A FIRST LOOK AT WHETHER OR NOT N-FERTILISER APPLICATIONS AFFECT COELIAC EPITOPE LEVELS IN NEW ZEALAND WHEATS

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Plant & Food Research (PFR) and the New Zealand (NZ) wheat growing, milling and baking industry have embarked on a strategy to reduce the levels of coeliac epitopes in foods made from NZ wheats. To do this we are looking at various points in the wheat value chain, to see how reductions might be achieved, whether it be through breeding, agronomy, milling or fermentation prior to baking. A major unknown in research related to levels of coeliac epitopes in wheats, is to what extent the addition of N-fertilisers might have an influence. Also, to what extent might irrigation and non-irrigation (dryland) make a difference? We are currently analysing two varieties of NZ milling wheat from a trial set up by the Foundation for Arable Research (FAR) during the 2017-2018 season at its Chertsey site in mid-Canterbury. Whether irrigated or dryland, treatments comprised application of six levels of N-fertiliser, mainly as urea, at growth stages 11, 30, 39 and 59. Total N (soil + applied) targets ranged from 35 (soil only) to 400 kg N per hectare. Mass spectral analysis of 6 target coeliac epitopes will be reported.

4A.2

DEVELOPING A MOLECULAR DIAGNOSTIC TOOL FOR WHEAT BREEDERS TO HELP IN PREDICTING WHEAT VARIETIES WITH REDUCED GLUTEN INTOLERANCE

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A considerable number of people, primarily in western populations, chose to follow gluten free diets these days and wheat flour products have gained the reputation of being controversial food. Prevalence of gluten related food disorders, e.g. Coeliac Disease, Wheat Allergy, Gluten Intolerance etc. have increased in the last 20 years and modern wheat varieties are often blamed. It is claimed that intensive wheat breeding during and since the green revolution has changed wheat from a safe nutritious food to one that has become allergenic. Gliadins are the principal immunoreactive fraction of gluten, due to the high content of specific immune reactive peptide sequences (epitopes) in their primary structures. Methodologies including Matrix Assisted Laser Desorption Ionisation Time of Flight Mass Spectrometry (MALDI-TOF), Liquid Chromatography MS MS (qTOF), and Reverse and Size Exclusion High Performance Liquid Chromatography, using Data Explorer, Genomic WorkBench, Excel, UniProt and ProPepper software were used to develop a breeder's too, to quantify gliadin content and composition of wheat cultivars and determined their immunoreactive epitope content. Using this tool, a small highly toxic ω-gliadin group was discovered, and the immunoreactive epitopes of its members were mapped. The allergenicity of 170 wheat cultivars was estimated, using this tool and it was clearly shown that historic wheat varieties are potentially as immunoreactive as the more recently released cultivars. Australian wheat breeding companies can now use this tool, to select varieties with low immunoreactivity.

4A.3

FREE AMINO ACIDS IN WHEAT GRAINS ARE POTENTIAL TARGETS FOR BREEDING HEALTHY FOODS

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In this study, the free amino acids (FAAs) in the seed of 96 Australian wheat varieties were examined for genetic variation and the potential for genetic manipulation by breeding. FAA pool in the wheat grain is highly reactive to environmental stress, and thus can add undesirable contaminants to processed foods. For instance, plant disease, sulphur deficiency, heat or nitrogen deficiency have been shown to significantly increase the level of free asparagine in the wheat grain up to 30-fold. Free asparagine is an important precursor for acrylamide, a neurotoxin and potential carcinogen that is formed in foods through a Maillard reaction. Acrylamide formation is almost exclusively determined by the level of free asparagine in the grain, and thus, manipulating the levels can significantly impact nutritional qualities of the wheat grain. To date, options to decrease the levels in food have been limited, due to recurring taste anomalies and consumer tolerance. Genome-wide association mapping with 9k SNP array was applied to 19 individual FAAs. The analyses identified nine SNPs significantly ($P < 0.001$) associated with free asparagine variation, and localized these on chromosome 5A. The genetic loci explained between 14% and 24% of the phenotypic variation in free asparagine, and would be valuable tools for further studies to mitigate the acrylamide risk in wheat products.

4A.4

HIGH AMYLOSE WHEAT: A NOVEL CEREAL TO BRIDGE THE 'FIBRE GAP'

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Most Australians do not meet the recommended intake target of dietary fiber. Wholegrains rich in resistant starch (RS) can help fill the fiber gap. While types of RS such as high amylose maize (HAM) starch are commercially available, their applicability in wheat-based products such as bread and noodle is limited. A recently developed high amylose wheat (HAW) high in RS can have potential applications in a wide range of wheat-based food. A range of HAW (37% ~93% apparent amylose content) was derived from altering starch branching enzymes (SBEs) in both bread wheat and durum wheat through TILLING (non-transgenic breeding). Mutations of both SBE IIa and IIb resulted in highest amylose content with significantly increased proportion of long amylopectin and amylose chains (DP>20, DP: degree of polymerisation). A range of physicochemical techniques was applied to characterize the structural and functional properties of HAW starch. Compared with wild-type starch, HAW starch showed distinct birefringence and crystalline pattern with a higher fraction of V-type polymorph (amylose complex). The indigestible starch fraction after *in vitro* digestion correlated positively with amylose content. However, the onset temperature (T_o) of gelatinization was not raised significantly by the mutations. Compared to HAM starch, there was a greater rise in T_o of HAW starch after annealing treatment.

4A.5

THE EFFECTS OF CARBOHYDRATE-RESTRICTIVE DIETS ON GLYCOGEN MOLECULAR STRUCTURE, AND IMPLICATIONS FOR DIABETES MANAGEMENT

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Starch digestibility influences human health in various ways, including modulating blood glucose level. Glycogen is a complex branched glucose polymer which is a storage reservoir for blood glucose. Liver glycogen contains small β particles which can form large bound aggregates denoted α particles. The latter are molecularly fragile in diabetic mice, readily forming smaller particles which degrade more rapidly to glucose: an effect perhaps correlated with the loss of blood-sugar homeostasis in diabetes. This study used mice as a model to test how starch digestion rate affects glycogen structure in both diabetic (DG) and healthy mice (HG). Healthy and diabetic mice were fed a standard chow containing normal maize starch (NMS) and high-amylose maize starches (which are slow to digest) for 6 weeks. Liver glycogen from DG mice fed with high-amylose diets were no longer molecularly fragile. This showed that diets with slow glucose release during digestion (a strategy used to help control blood sugar in human diabetic management) are able to alter diabetic glycogen molecular structure to resemble that of healthy mice, an affect probably because of reduced blood-sugar level.

4B.2

EFFECT OF DIFFERENT STABILIZATION TREATMENTS ON THE FATTY ACID CONTENT, PHENOLIC COMPOSITION AND ANTIOXIDANT ACTIVITY OF REIZIQ RICE BRAN

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Rice is an important cereal crop that is consumed by more than half of the world's population. The outer layer of rice, known as rice bran (RB), is usually discarded or used as animal feed due to its shorter shelf-life which can lead to rancidity, unpleasant odours and flavours. However, it has been identified as a valuable source of bioactive phytochemicals that may act as protective agents against cellular and biomolecular damage. Numerous stabilisation processes are currently applied to RB in order to prevent the rancidification process and thus improve RB shelf-life. However, the application of such treatments has been observed to alter the fatty acids, chemical profile and antioxidant activity. The aim of this study was to evaluate the influence of stabilisation methods on the fatty acid profile, phenolic composition and antioxidant activity of RB. The samples under investigation were freshly milled non-stabilised RB (NS-RB) and RB that had undergone either extrusion (ES-RB), microwave (MS-RB) or oven stabilisation (OS-RB) processes. Bench-top assays such as Folin-Ciocialteu total phenolic content (TPC), 1,1-diphenyl-2-picrylhydrazyl (DPPH), and 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) (ABTS) assays were employed to determine the antioxidant capacity of the various samples. Subsequently, Gas Chromatography Mass Spectroscopy for fatty acid profiling and Ultra High Performance Liquid Chromatography (UHPLC) with diode array detection coupled to an online ABTS system for the chemical profiling of phenolic compounds present in the samples. Results obtained displayed no significant differences in the fatty acid profile among the different stabilization treatments. RB was observed to be abundant in palmitic acid (16.84%), stearic acid (1.36%), oleic acid (42.38%), linoleic acid (35.64%) and linolenic acid (1.52%). However, TPC, DPPH and ABTS bench-top assays demonstrated ES-RB to contain significantly ($p<0.001$) higher total phenolic content as well as higher antioxidant activity in comparison to MS-RB, OS-RB and NS-RB. Similarly, UHPLC and online ABTS analyses also demonstrated a clear distinction between the various stabilisation treatments. ES-RB was again found to have a significantly ($p<0.001$) higher number of phenolic compounds with corresponding antioxidant activity compared to MS-RB, OS-RB and NS-RB. In conclusion, although there was no significant differences found in the fatty acid profile, a clear distinction was found between the bioactive components present in RB that has undergone different stabilisation treatments. ES-RB had the highest total phenolic content which correlated well with the increased antioxidant activity observed within this sample compared to the other RB samples. This study has demonstrated that ES-RB may be a crucial technique that can be applied to RB to ensure essential phenolic compounds with antioxidant activity remain intact.

4B.3

PREPARATION OF GAMA-AMINOBUTYRIC ACID-ENRICHED RICE BRAN AND ITS MODULATION ON GUT MICROBIOTA AND COGNITIVE FUNCTION OF RATS IN HIGH-FAT DIET

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In this study, gama-aminobutyric acid (GABA) in rice bran was promoted to be 8 times higher than its original one via anaerobic incubation. The GABA enriched rice bran (ERB) demonstrated a significantly increased anti-oxidant capacity following the incubation. The consumption of high-fat diet (HFD) with ERB was found to stimulate butyrate and propionate production by promoting *Anaerostipes*, *Anaerostipes* sp. and associated synthesizing enzymes. This altered short-chain fatty acids distribution further enhanced circulatory levels of leptin and glucagon-like peptide-1, controlling food intake by down-regulating orexigenic factors. Delightedly, the current study found GABA supplement delivered by rice bran significantly promoted hippocampal sulfatides synthesis, and reversed the HFD-induced sulfatides deficiency and oxidative-triggered mild cognitive impairment. Elevated GABA concentration in the hippocampus and the activation of GABA B-type receptors might be the primary contributors. This study highlights the potential of GABA enriched rice bran as a novel dietary supplement for benefiting the attenuation of chronic diseases.

4B.4

RICE QUALITY FROM BREEDING AND INDUSTRY PERSPECTIVES

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Quality of rice is the central focus for any breeding program and industrial processing. The Australian Rice Partnership Project (II) is mainly focused on delivering niche and premium quality varieties, with added health benefits, suitable for growing in the Australian climate. But with increasing adversity with climate change and water availability, the dimension of the rice production system is changing. For example, for rice grown under aerobic conditions, use of less water per MT of paddy production, and tolerance to cold or heat, has direct impact on rice quality. On the other hand, with increasing pressure from competitors with lower production costs and subsidised export, the Australian rice industry needs to be more competitive by supplying premium quality rices and varieties with unique health benefits. To address these issues, the Australian Rice Breeding Program is adopting different quality checks in its early selection process. In producing a premium quality product targeted to specific domestic and international markets and to maximise returns to growers' and processors, rice quality should encompass aspects of growing, harvesting, drying, storing and milling rice. There are many challenges in controlling and maintaining the quality of large rice tonnages from varied growing histories, and this presentation will focus on those challenges from breeding and industrial perspectives.

4B.5

RICE-DERIVED POLYPHENOLS REDUCE INFLAMMATION AND OXIDATIVE STRESS BIOMARKERS IN HUMAN UMIBILICAL VEIN ENDOTHELIAL CELLS

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Global obesity rates are of epidemic proportion. Anti-obesity treatments are in high demand and many have adverse side effects. Obese populations have higher levels of inflammation and oxidative stress. As a result, obesity is significantly correlated to other lifestyle diseases such as cardiovascular disease. Endothelial dysfunction, a predecessor to atherosclerosis is a well-established response to cardiovascular risk factors in high inflammatory and oxidative stress environments. The antioxidant and anti-inflammatory properties of polyphenols in coloured rice varieties could have potential to neutralize oxidative stress and modulate inflammatory responses in obese populations. Three coloured rice varieties were chosen based on previous polyphenolic and antioxidant screening and their antioxidant and anti-inflammatory potential were investigated. Human umbilical vein cells (HUVECs) were incubated with polyphenol extract (PE) from three coloured rice varieties: Reiziq (brown), Purple (purple) and Yunlu29 (red) and subsequently subjected to oxidative stress conditions. The production and/or expression of reactive oxygen species (ROS), pro-inflammatory cytokines, nuclear factor kappa-B (NF-κB) and a naturally-occurring intracellular antioxidant (SOD-1) were quantified by fluorescence spectroscopy, flow cytometry and ELISA respectively. ROS and SOD-1 were significantly reduced and upregulated ($p < 0.001$) in HUVECs treated with Purple rice PE respectively. Interestingly, Yunlu29 extract exhibited the highest anti-inflammatory potential in HUVECs with a significant ($p < 0.001$) reduction in interleukin-6 (IL-6) and interleukin-8 (IL-8) production. NF-κB expression was significantly ($p < 0.001$) reduced in HUVECs treated with PE from all three rice varieties. However, Yunlu29 reduced NF-κB expression greater than Purple and Reiziq. Anthocyanins, are the predominant polyphenols present in Purple rice which may be attributed to the reduced ROS and increased SOD-1 observed in this study. Yunlu29 and Reiziq PE are primarily comprised of phenolic acids which have associated anti-inflammatory properties, that may contribute to reduced cytokine production and NF-κB expression. The polyphenol profile of coloured rice varieties may play a key role in targeting specific therapeutic pathways in obesity-related oxidative stress and inflammation. Study outcomes may facilitate selective breeding of coloured rice varieties to contain polyphenols of therapeutic benefit which may serve as a potential functional food in reducing risk factors associated with cardiovascular disease.

5A.1

UNDERSTANDING THE GENETICS OF WHEAT QUALITY USING MAGIC POPULATIONS

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Wheat breeding requires assessment of both agronomic and quality parameters to ensure the varieties developed meet both farmers and end users requirements. Throughout the breeding process, grain and flour are valuable and scarce – a limiting resource. This limitation and the cost and complex nature of wheat based end-product evaluation mean quality assessment occurs late in the breeding cycle. This creates a bottle neck in wheat breeding programs and can result in agronomically advantageous lines being eliminated late in the breeding cycle. This represents a loss to breeders and growers, and thus robust genetic markers for end-product quality are required to mitigate against this. To identify robust markers of quality CSIRO undertook the development of Multi-parent Advanced Generation InterCross (MAGIC) populations capable of overcoming the limitations of bi-parental and association mapping populations. The resulting 4 and 8 parent MAGIC populations are presently being utilised in a multi-year, multi-site study to identify genetic markers of wheat quality. These assessments include test weight, grain protein, milling yield, water absorption, wet gluten content and straight dough baking. Three site years from the 4-parent, two from Eastern Australia, and one from Western Australia, and four site years (from both Eastern & Western Australia) from the 8-parent MAGIC population are being assessed. Here we present the results quality assessment of grain, flour and straight dough bread making quality of the 4-parent and 8-parent sites and the genetic factors controlling these traits.

5A.2

GENOME MAPPING OF THE PROLAMIN SUPERFAMILY PROTEINS IN WHEAT FACILITATES THE UNDERSTANDING OF THEIR FINE-TUNED ROLE IN STORAGE MATERIAL ACCUMULATION, STRESS RESPONSES AND HUMAN HEALTH

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Wheat is an important staple grain for human-kind globally because of its end-use quality and nutritional properties and its adaptability to diverse climates. The last thirty years extensive research has been carried out on the quantity and composition of prolamin proteins in the grain and their primary role in end-use quality. However, there was no precise knowledge available of the exact number of their encoding genes and their broader gene family structures. Establishing the content and distribution of the prolamin superfamily regions in wheat has been hampered by the complexity of the wheat genome and lack of complete genome sequence information. In this presentation we provide a novel insights into the wheat prolamin superfamily based on a comprehensive analysis and annotation of the wheat Prolamin Pfam clan proteins using the new IWGSC RefSeq v1.0 wheat genome sequence, their expression patterns under different environmental conditions and their complex role in nutrient storage, stress resistance and human health. For a small proportion of the population, specific wheat proteins can trigger adverse immune responses and clinical manifestations such as celiac disease, wheat allergy, baker's asthma and wheat-dependent exercise-induced anaphylaxis (WDEIA). Majority of these immuneresponsive proteins belong to the grain prolamin superfamily with a primary function of nutrient storage and stress defense. Celiac disease and WDEIA genes are primarily expressed in the starchy endosperm and show diverse variation in protein- and transcript-level expression in response to temperature stress. Non-specific lipid transfer proteins and alpha-amylase trypsin inhibitor gene families, implicated in baker's asthma, are primarily expressed in the aleurone layer and transfer cells of grains and are more sensitive to cold temperature. Our study establishes a new reference map for wheat prolamin proteins and provides a fresh basis for selecting wheat lines and developing markers and diagnostics for products with more favorable consumer attributes.

5A.3

EXPLORING POTENTIAL CANDIDATE GENES AND DISCOVERING NEW MOLECULAR MAKERS BY QTL MAPPING TO IMPROVE NITROGEN USE EFFICIENCY FOR AUSTRALIA WHEAT BREEDING

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Wheat is one of the largest crop species around the world and a very important starch and protein source for human, much effort has been devoted to breed for new varieties with higher yield and protein content. To improve wheat nitrogen use efficiency (NUE) is of great importance as it can help to improve wheat market price, end use quality while reduce production input and alleviate environmental pollution. NUE is a quantitative trait and studies have reported genetic variations for NUE and its components in wheat. Through the traditional QTL mapping method, we investigated important NUE related traits under different nitrogen rates in different sites using a double haploid population, several genetic regions which are closely related to wheat NUE were identified. Combing the bioinformatics analysis using wheat reference map and next generation sequencing (NGS) as well as metabolomics study, we are on the way to discover potential candidate genes and molecular makers associated with NUE which can be used in Australia to breed new varieties with higher yield and grain protein content.

5A.4

EVOLUTION AND FUNCTION OF WHEAT GRAIN AVENIN-LIKE PROTEIN

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The recently discovered non-gluten prolamins, avenin-like proteins (ALPs) in wheat can improve flour baking qualities. In our study, 15 *TaALP* genes were identified. Phylogenetic analysis showed that *TaALP* genes formed three major clades, types a, b, and c. The allelic variation of ALP genes in a wild emmer wheat (*Triticum turgidum ssp. dicoccoides*) populations from Israel were investigated to study the evolution of *TdALP* genes under different micro environments. In total, 49 alleles were identified at 4 *TdALP* loci. In this project, we found that *TaALP* genes are pathogen-inducible. Expression levels of *TaALP* genes and some PR genes were analysed by quantitative RT-PCR in developing caryopses at 7, 13 and 42 days after pollination. Differential expression patterns of *TaALP* genes were identified in plants infected by *Fusarium graminearum*. Recombinant *TaALP*-encoded proteins significantly inhibited the fungal growth *in vitro*. mRNA *in situ* hybridization confirmed that *TaALP* transcripts were upregulated in aleurone, sub-aleurone, and embryos after infection. Genome-wide FHB index association analysis indicated that certain *TaALP* alleles were significantly correlated with FHB resistance. The ALPs may act as pathogen resistance proteins mediated by systemic acquired resistance (SAR). Our research indicated that *TaALP* genes, characterized by typical gliadin domains, are broad-spectrum, partial-resistance genes that contribute to sustainable control of wheat pathogen disease and possibly other fungus-induced disease in wheat. This exciting finding will be applicable for breeding broad range of disease-tolerant and high-quality wheat varieties for sustainable wheat production.

5A.5

THE GENETIC CONTROL OF WHEAT QUALITY: A COMPLEX PUZZLE

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The ultimate quality of wheat-based products depends on the variety originally sown (breeder responsibility), the growth and harvest conditions (grower responsibility) and the subsequent effectiveness of processing. The breeder's role, basic in this sequence of events, requires knowledge of the genes that control each of the several grain-quality attributes, namely, dough strength and extensibility, protein content, grain hardness, milling yield, starch-paste viscosity, baking quality, and nutritional value. Ideally, we also know the route of action of the genes responsible (via mRNA, polypeptides, proteins and other chemical components) to provide each quality characteristic. Knowledge of this genetic information permits the breeder to discard less suitable lines early in the selection process. We have much of that information for some attributes, especially dough properties, grain hardness and starch-paste viscosity, but not for other aspects. Advances in DNA-sequencing technology have recently permitted the analysis of very large data sets. In particular, transcriptomics permits study of the genes that are active during grain filling. By these novel approaches, we have found the gene *wbm* to be associated with bread quality, and that grain hardness is associated more with the levels of expression of the *pin* genes than their amino-acid sequences. A group of cell-adhesion proteins (*FLA-8* alleles) have been shown to be associated with flour yield in milling. The nutritional value of whole-grain products may be enhanced by new genetic information about increasing the contributions of aleurone cells to mineral and vitamin content.

5B.1

TOWARDS PREDICTING STARCHY FOOD DIGESTIBILITY: CHARACTERISATION OF STARCH BY CAPILLARY ELECTROPHORESIS, NMR SPECTROSCOPY AND MORE!

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Low GI food and grains are attracting attention from consumers and governments paying more and more attention to the relation between our food and our health. Measuring GI accurately is however a long and costly process. It is not a tool for developing new grains or new foods and testing 1000s of samples. In vitro digestibility measurements are offering higher throughput and repeatability but they are still time consuming. Apparent amylose content has some correlation with in vitro GI.1 Starch has six levels of structure. Our objective is to describe and quantify these 6 levels of structure in order to see if they could be used as predictors of digestibility.

Analysis of the branching structure of starch requires an analysis in solution. We found that only dry dimethylsulfoxyde (DMSO) can dissolve starch quantitatively. The molar mass distribution of native starch can however not be determined accurately by Size Exclusion Chromatography (SEC/GPC). Starch may be composed of oligomers, in the protein chemistry sense, in solution and the molar mass of starch macromolecule may in fact be irrelevant. Characterisation of branching in starch has received a lot less attention. Iodine-affinity capillary electrophoresis (IA-CE) offers a robust separation by branching similar to what was obtained for synthetic branched polymers. We will show how IA-CE enables the determination of distributions of electrophoretic mobilities, their averages and dispersities. These show that there is for example a strong heterogeneity in terms of branching in amylose. We also examine the higher levels of structure by probing the chain dynamics of starch by solid-state 1H NMR spectroscopy.

5B.2

A HIGH THROUGHPUT IN VITRO DIGESTIBILITY ASSAY FOR RAPIDLY PREDICTING GLYCAEMIC INDEX OF RICE VARIETIES

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The aim of this study was to construct the high throughput needs of rice breeding programs for rapidly predicting the glycaemic index (GI) of rice varieties. Milled rice grains from varieties (Opus, Koshihikari, Reziq, Topaz, Doongara, YRL127, Sherpa, Illabong, Langi and Waxy) differed by GI were subjected to an *in vitro* enzymatic digestion by a mixture of pancreatic α-amylase and amyloglucosidase (*Aspergillus niger*). An aliquot of digesta was pipetted at each time points, of which the generated glucose concentration measured through Megazyme GOPOD assay and calculated into the starch digested percentage. Digestion curves were generated by plotting starch digestion percentages *vs*. time and the first order kinetic parameters of starch digestion were obtained through the combined techniques of logarithm-of-slope analysis and non-linear least-squares fitting method, which allow for an accurate determination of critical parameters including predicted GI, areas under curves and/or digestion rate coefficients. This *in vitro* digestibility assay allows for a rapid prediction of the GI to screen large number of rice lines within tight timeframes, and has the potential to assist in the delivery of new low GI rice cultivars.

5B.3

EFFECTS OF PECTIN ON DIGESTIBILITY, VISCOSITY AND MOLECULAR STRUCTURAL CHANGES OF STARCH DURING *IN VITRO* DIGESTION PROCESS

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Starch digestion rate is strongly related to metabolic diseases such as obesity and diabetes. Starchy foods always contain non-starch components, which can affect starch digestibility. Mixtures of the ungelatinized starch and pectins with low and high degree of esterification were used to investigate pectin's effect on starch digestibility rate and evolution of starch molecular structure during digestion using amyloglucosidase and pancreatin. The whole-molecule size distribution and the chain-length distribution of chains were measured by size-exclusion chromatography and fluorophore-assisted carbohydrate electrophoresis. Digestion profiles and changes in molecular size distributions of whole and debranched digesta during digestion show that addition of low methoxyl pectin significantly decreased starch digestion rates. While pectin did not change the amylose/amylopectin ratio during most of the digestion, it decreased the digestion rate of short amylopectin chains compared to long ones. Dynamic laser scattering and confocal laser scanning microscopy data suggested that a major contributor to this digestion rate change is from substantial pectin/amyloglucosidase interaction. This suggests an approach to designing nutritionally more beneficial starch-based foods by taking account of interactions between pectin and digestive enzymes.

5B.4

THE IMPACT OF PROCESSING ON STARCH DIGESTIBILITY

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The rice production process involves growing, harvesting, storage and milling. In particular, nitrogen nutrition and storage conditions influence milling properties (head rice yield), translucense and colour. Given that the positive health properties of rice are of increasing interest to the consumer and the food industry, research into the impact of production processing on GI is warranted. An in vitro starch digestibility method was used to screen two sets of samples. For sample set (1), milled rice varieties were exposed to high application rates of nitrogen (240 kg/HA) and samples were collected over three crop years. The extreme rates of nitrogen-treated samples, which also had the highest protein contents, showed no difference in starch digestibility to samples which were not treated. For sample set (2), milled rice varieties were stored at 3 temperatures (4, 25 and 37 °C) for up to 1 year. Samples were collected over 5 time-points over the year. The starch digestibility decreased with increasing storage time and temperature. The outcome of this project provides important information on the limits of endogenous rice proteins on starch digestibility as well as the importance of controlling temperature and moisture during storage.

5B.5

MONITORING *IN VITRO* DIGESTION OF RICE STARCH USING CAPILLARY ELECTROPHORESIS ONLINE

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Starch digestion is integral to human nutrition and starch digestibility can have a profound impact on an individuals' health. For example, resistant starches are promoted to combat obesity due to their resistance to digestion. Human *in vivo* starch digestibility assays such as the widely used glycaemic index (GI) are expensive and prone to generation of variable data. The blood glucose response to any food varies widely in large part because of the wide metabolism variability between individuals. For these reasons, more reproducible in vitro digestibility assays with relatively few tightly controlled components have been developed to generate equivalent results to in vivo GI. However, these methods are typically end-point assays which only monitor glucose. Capillary electrophoresis (CE) with direct UV detection was shown to be robust when quantifying sugars released from in vitro digestion of heterogeneous breakfast cereals offline and sugar consumption during fermentation. In this study, CE with direct UV detection was applied to measure glucose as a starch digestibility marker, and glucose precursor intermediate sugars, maltotriose and maltose as alternative starch digestibility markers that may further our understanding of starch digestibility. The release of these sugars was monitored with CE from in vitro digested rice starch online with little to no sample preparation. The protocol was robust and precise using various hydrolytic enzymes. It identified sugars with ≤1% relative standard deviation (RSD) and quantified sugars with ~10% RSD. We envision this method will have an application in the determination of in vitro glycaemic response and in vitro glycaemic potential between different rice varieties and other starchy foods and provide new insights into the kinetics of in vitro starch digestion which can complement in vivo starch digestibility assays.

6A.1

IMPORTANCE OF TARGETED END-TO-END RESEARCH IN CEREAL GRAIN QUALITY FOR INDUSTRY IMPACT.

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Cereal breeding is a long journey. Even with recent technological advances (e.g. predictive genomics, phenomics, machine learning), assembly of parental germplasm and selection of superior recombinants from these parents approaches a decade long time-frame, even for a well-defined and active breeding program. Further, as direct grain quality estimation is expensive, it is thus only initiated when high confidence for other key economical attributes (e.g. yield, disease) are attained. The process to identify and achieve new "high value or value added" breeding target will at least doubling this time frame. As such, integration of research concepts, be they novel predictive selection technology or breeding a novel trait, must be considered in an end-to-end system between researchers and breeders to ensure timely industry impact.

Herein, we present two relevant situations to the Australian cereal community. Firstly, "Knowing your customer", and the successful breeding for Udon noodles in WA. Udon noodles are a white salted noodle popular in Japan, and have essential quality aspects such as brightness, colour and its' stability, with high importance on sensory texture and mouth feel in a soft grained wheat. These attributes were divergent to standard Australian breeding targets of the time, but present in local WA cultivar Gamenya. Gamenya was preferentially sought by Japanese millers for Udon production during the 1970's and 1980's. When Gamenya was replaced, Japanese millers reacted and WA cereal chemist Dr. Graham Crosbie visited their mills to understand the issue. Upon his return, in conjunction with the WA breeding program, Crosbie initiated targeted cereal chemistry testing for key Udon traits, Cadoux was rapidly released in the late 1980's. Further, the WA breeding program continued to breed and select for key attributes of Udon noodles, underpinned by reciprocal cereal chemistry research between WA and Japan to ensure breeding for new Udon cultivars such as Supreme, Zen, Ninja and Kinsei are fit for purpose.

Secondly, we present an open question in barely. For malting barley, the critical quality research to support variety development remains the provision of improved descriptive characteristics of the grain and malt. Adequate description of functional grain properties and malt could remove the "requirement" for variety name to form part of the description of brewing ingredients. If possible, removal of variety name from grain and malt characteristics would allow release of new varieties without the need for malting and brewing trials; globally these trials add millions of dollars annually to introduction costs for new varieties, and delays the benefit utilization of these varieties to both producers and end-users. Further, this lack of adequate descriptive parameters forces the malting industry to adopt segregation systems that add considerable supply chain costs and restrict the number of varieties available to growers. With a complete understanding of the functional characteristics of the grain and malt, and analytical tools to measure these characteristics, both maltsters and brewers could confidently predict both grain and malt behavior without the need for "empirical" descriptions provided by variety name.

6A.2

GENETIC TOOLS TO PROTECT WHEAT FROM THE IMPACT OF HEAT STRESS

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Wheat is the mainstay of the Australian grains industry, accounting for 56% of total grain tonnage produced annually. Heat waves of >30 °C for ~3 days are known to reduce grain yield and grain weight. On the other hand, our research has shown that heat stress can have positive impacts on aspects of grain quality such as grain protein content, dough physical properties, the proportion of high molecular weight gluten polymer present in the dough, and pasta end-use traits. Episodes of heat waves are common in Australia's wheat belt and are predicted to worsen with climate change, so the challenge will be how to stabilise grain yield and grain size into the future. Our main strategy to tackle this problem is to develop DNA markers to assist the breeding new heat tolerant varieties. In doubled haploid progenies of a cross between Australian varieties Drysdale and Waagan we identified two major loci for grain size stability, one on chromosome 3B using heat treatment (37°C/27°C day/night for three days during early grain filling in a growth chamber), and the other on chromosome 6A, using field experiments. The beneficial allele on chromosome 3B was inherited from Waagan, and halved losses in 1000-kw otherwise caused by the heat treatment in lines carrying the Drysdale allele. Near-isogenic lines are being used to validate the effects of the chromosome 3B allele in the field, and determine environmental factors that impact on the expression of the QTL. The beneficial allele on chromosome 6A was derived from Drysdale, and conferred up to 2.21 g higher 1000-kw in field experiments conducted across years, locations and sowing dates. The Drysdale allele increases both grain length and width, and the chromosomal location suggests it might be related to TaGW2, the wheat homologue of RING-type E3 ubiquitin ligase (OsGW2) gene associated with increased thousand grain weight and grain width in rice.

6A.3

CONTRIBUTIONS OF TaSUTs TO GRAIN WEIGHT IN WHEAT UNDER DROUGHT

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Sucrose transporters (*SUT*) play crucial roles in wheat stem water soluble carbohydrate (WSC) remobilization to grain. To determine the major functional *SUT* gene groups in shoot parts of wheat during grain development, drought tolerant varieties, Westonia and Kauz, were investigated in field drought experiments. The homologous genes to *OsSUT1-5* were identified, namely *TaSUT1_4A*, *TaSUT1_4B*, *TaSUT1_4D*; *TaSUT2_5A*, *TaSUT2_5B*, *TaSUT2_5D*; *TaSUT3_1A*, *TaSUT3_1D*; *TaSUT4_6A*, *TaSUT4_6B*, *TaSUT4_6D*; *TaSUT5_2A*, *TaSUT5_2B*, and *TaSUT5_2D*, and their gene structures were analysed. Wheat shoots were harvested from pre-anthesis to grain maturity and the stem, leaf sheath, rachis, lemma and developing grain were used for analysing *TaSUT* gene expression. Physiological traits related to yield were characterized. The study showed that among the five *TaSUT* groups, *TaSUT1* was the predominant sucrose transporting group in all organs sampled, and the expression was particularly high in the developing grain. In contrast to *TaSUT1*, the gene expression levels of *TaSUT2*, *TaSUT3* and *TaSUT4* were lower, except for *TaSUT3* which showed preferential expression in the lemma before anthesis. The *TaSUT5* gene group was very weakly expressed in all tissues. The upregulated gene expression of *TaSUT1* Westonia type in stem and grain reveal a crucial role in stem WSC remobilization to grain under drought. The high *TaSUT1* gene expression and the significant correlations with thousand grain weight and kernel number per spike demonstrated the contribution in Kauz's high grain yield in an irrigated environment and high TGW in Westonia under drought stress. Further molecular level identification is required for gene marker development.

6A.4

EFFECT OF GENOTYPE, ENVIRONMENT AND PROCESSING ON STARCH MOLECULAR STRUCTURE AND SOME PHYSICOCHEMICAL PROPERTIES OF OAT FLOUR

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Consumption of oats for food has been increasing recently for health reasons mainly due to the ability of oats to help regulate blood glucose and lower cholesterol. Oats are used in various food products such as breakfast cereals, beverages and bread. In these products, the properties of the starch may be critical to their eating quality. Therefore, understanding factors influencing the composition, structure and properties of starch is required to utilise oats effectively in product making. This study aims to determine the effects of genotype, growing environment and processing on the molecular structure of oat starch and some functional properties of oat flour. Eight oat cultivars grown at four sites in Australia over two years (2015 and 2016) were used in this study.

Results showed that genotype, environment and processing each had significant impact on pasting and gelatinization properties of oat flour and starch molecular structure ($p < 0.05$). Environment was the major influence on pasting and gelatinization properties. The Western Australian sites had higher onset, peak gelatinization temperatures and gelatinization enthalpy while the South Australia sites showed significantly higher peak viscosity, trough viscosity and peak time ($p < 0.05$). The pasting properties of oat flour positively correlated with beta-glucan content but negatively related to total starch content. This implies that not only starch content but also beta-glucan contribute to the pasting properties of oat flour. The heat treatment results in the decreases in breakdown viscosity, final viscosity, setback viscosity and increase in pasting temperature of groats, while peak viscosity remained unchanged during the heat treatment. The heat treatment also affects gelatinisation properties of oat flour. The heat-treated groats have higher gelatinization temperatures but lower gelatinization enthalpy than the non-heat-treated groats.

These results indicate that the physicochemical properties of oat end products could be improved by selecting specific oat cultivars from certain growing locations.

6A.5

GENETIC CHARACTERIZATION OF TA-NACS GENE ACROSS AUSTRALIAN WHEAT CULTIVARS IN RELATION TO SENESCENCE AND THOUSAND KERNEL WEIGHT

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TaNACS transcription factor has shown effects on senescence revealed using transgenic approach. However, to date the genetic architecture of *TaNACS* gene is unclear, making impractical to utilize it in wheat breeding. To determine the gene structure, promoter characteristics and cis-regulatory motif composition, sequencing of protein coding and upstream 1000bp sequence has been done in 48 Australian wheat cultivars using genome specific primers. In the current study, three genes of *TaNACS* were identified and mapped to chromosome 7AL, 7BL, 7DL. The protein coding sequence of 7A, 7B, and 7D were 870bp, 879bp, and 876bp long encoding 289, 292, and 291 amino acid long proteins respectively. Two alleles were identified for *TaNACS-7A*, three alleles for *TaNACS-7B*. No allelic variation was found for *TaNACS-7D*. *TaNACS-7A* can be further classified into two types based on 36bp insertion found in 142bp upstream of start codon, while no significant clustering was found for *TaNACS-7B* and *TaNACS-7*D promoter sequence. Quantitative RT-PCR analysis of 3 different tissues collected at different developmental stages from 2 types of cultivar revealed that *TaNACS* expression was higher in second leaf than flag leaf and no expression found in grain tissue. Moreover *TaNACS -7A*, *TaNACS-7B*, and *TaNACS-7D* expression varies in two types of cultivars at different developmental stages. Phenotyping data collected from 48 Australian wheat cultivars established a highly significant association of the *TaNACS-7A* allele with chlorophyll content and thousand kernel weight. The present study would facilitate us to further study *TaNACS* genes by exploring their regulatory networks and functional characterization.

6A.6

HIGH AND LOW MOLECULAR WEIGHT GLUTENIN SUBUNIT ALLELES OF HISTORIC AND MODERN AUSTRALIAN WHEAT VARIETIES AND THEIR EFFECT ON DOUGH RHEOLOGY

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Gluten is composed of glutenin and gliadin fractions. Among them, glutenin is the major protein fraction contributing to gluten functionality and is further comprised of high and low molecular weight glutenin subunits (HMW-GS and LMW-GS). The percentage of HMW-GS and LMW-GS is variety dependent and genetically controlled. Therefore, the knowledge of allelic composition of HMW-GS and LMW-GS is very important for breeding varieties of desirable quality traits. The aim of this study was to identify the allelic composition of HMW-GS and LMW-GS of Australian wheat varieties and also to investigate the effects of changes in composition of HMW-GS and LMW-GS and quantity of glutenin and gliadin fractions on dough quality of old and modern wheat varieties. A set of 78 varieties released in Australia between 1860 and 2015 were selected. The protein compositional studies were carried out using matrix-assisted laser desorption/ionization time of flight mass spectrometry (MALDI-TOF/MS) and High Performance Liquid Chromatography (HPLC). Dough rheological characteristics were investigated by Mixograph, Micro-doughLAB and Extensograph tests and the results were then statistically analyzed in relation to the protein composition data. A total of 14 different HMW-GS alleles and 15 LMW-GS alleles have been identified (3 at Glu A1, 9 at Glu B1 and 2 at Glu D1, and 5 at all the three LMW-G loci). It was observed that the presence of GluB1al and GluB1i, GluB1u alleles, together with the GluD1d allele is associated with superior dough quality. Similarly, the LMW-GS also had significant effect on dough rheological characteristics: GluA3b and GluA3c along with GluB3b and GluB3h in modern varieties were also related to dough strength and extensibility. In addition to this, the polymer size distribution, characterized by the % of un-extractable polymeric proteins (UPP%) has also been considered one of major contributors of gluten quality in modern varieties.

Overall, the results of this study suggested that the systematic selection in wheat breeding resulted in development of wheat cultivars in more recent years with improved glutenin to gliadin ratio and decent sets of glutenin alleles, leading to improved dough and superior bread making quality.

6B.1

GM AND GENE EDITED SORGHUM WITH LARGER GRAIN AND HIGHER PROTEIN CONTENT: GLASSHOUSE AND FIELD TRIALS

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Sorghum is a major staple cereal with over 500 million people worldwide dependent on it every day in sub-Saharan Africa and India. We have used genetic engineering and CRISPR/Cas9 gene editing approaches in parallel to improve key quality parameters of sorghum: grain size, protein content and protein quality. We have targeted the kafirin seed storage proteins, which affect digestibility in monogastric animals. Using a sorghum inbred line, Tx430, we have manipulated the kafirin seed storage proteins, signalling proteins involved in grain size, and foldase enzymes which are key components in packaging the endosperm protein:starch matrix. This has led to altered grain size, digestibility and end-use processing qualities. Selected lines were grown in Australia's first GM sorghum field trial in 2018. Sorghums produced include lines with increased grain number, increased grain size, and protein contents of 15-16% compared to the parent at 11% protein. A number of transgenic lines have both larger grain and more grain compared to Tx430, with thousand kernel weights up to 75% higher than the check lines. We have also produced plants with altered panicle morphology and productivity traits. We have optimised CRISPR/Cas9 gene editing to target key genes involved in sorghum grain quality, and will field trial these outcomes as soon as OGTR legislation becomes clear by the end of 2018.

6B.2

OPPORTUNITIES FOR AUSTRALIAN SORGHUM: FROM LOW VALUE COMMODITY TO HIGH VALUE MARKET SHARE

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Sorghum is largely considered in Australia to be a low value commodity, despite its importance to the Australian northern cropping system, and value as animal feed. However, sorghum's true value to Australia may not yet have been realised. Internationally, certain varieties of sorghum are also used in products for human consumption, both domestically and commercially. One such use is in the production of baijiu, a popular Asian drink considered to be the national drink of China. The crystal clear alcoholic spirit is one of the oldest distilled liquors in the world and is inextricably entwined into Chinese culture and traditions, being associated with happiness and prosperity. While some varieties of the iconic drink sell for just a few dollars per bottle, higher end varieties with specific quality requirements retail for upwards of two thousand dollars a 750 mL bottle (Australian dollar equivalent). Whether the Australian industry decides to meet the evaluated demand by assuring supply, and generating appropriate quality parameters and assurances is yet to be seen. A quantitative survey of more than 2000 Chinese baijiu drinkers sought to understand some of the unique purchase and consumption characteristics of Chinese consumers of baijiu, with a focus on choices around culture, happiness and wellbeing.

6B.3

NEW APPLICATIONS FOR AUSTRALIAN SORGHUM GRAIN IN FOODS AND BEVERAGES

Thomas H. Roberts, Ali Khoddami, Hoi Teng Kuan, Blake Cunio, Georgia L. Readett and Tandy Saputra

Sydney Institute of Agriculture, University of Sydney, NSW 2006

Sorghum is a highly heat- and drought-tolerant crop, and thus may grow in importance as a food and feed source as the global climate becomes warmer and more variable. While sorghum grain is utilised for a broad range of foods and beverages in many regions of the world, including India, China and several African countries, Australian-grown sorghum is utilised almost exclusively for animal feed. A limited number of sorghum-based food products are available to Australian consumers, marketed mainly on the basis of their gluten-free status (e.g. gluten-free Weet-Bix^{TM}). Development of new applications for sorghum grain in foods and beverages may stimulate Australian companies to create new value-added products from this healthy but underutilised grain. These products may or may not be gluten-free, depending on the need to incorporate gluten-containing cereal fractions into the product. We are currently testing the potential for Australian sorghum grain to be used as a substantial ingredient in a range of products including sweet biscuits, sausage filler, and Up&Go^{TM}-style drinks. Biscuits were made using a basic recipe incorporating red sorghum whole-grain flour and wholemeal wheat flour at levels of 100% sorghum, 50:50 sorghum:wheat and 100% wheat, and their physical and sensory properties compared. Beef sausages were made from chuck steak, beef fat and a filler consisting of whole-grain red sorghum flour, and were tested for shelf-life, physical properties and taste in comparison to non-sorghum-containing control sausages. For the Up&Go-style drinks, whole-grain sorghum flour was used as a partial substitute for oat flour to create model drinks, which were then tested for physical stability, antioxidant activity and other properties. Results of our analyses of these products will be presented and the future potential for Australian sorghum in foods discussed.

6B.4

FERMENTATION PERFORMANCE OF CURRENT AUSTRALIAN SORGHUM VARIETIES

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Sorghum is an important raw material for the production of *Baijiu* - a major distilled spirit produced and consumed in China. *Baijiu* typically has an ethanol content of 40-60 vol% and is most often consumed neat. This Chinese grain liquor is the most-consumed spirit in the world, and has the highest-value market by turnover. *Baijiu* is produced in very large quantity in China with Sichuan, Guizhou, Shandong, Jiangsu, Anhui and Henan provinces collectively claimed to produce more than 90% of the total liquor output. This represents a potentially large and valuable market for Australian sorghum. This study investigates the effects of different Australian sorghum varieties on ethanol fermentation performance. Major commercial sorghum varieties (13) were fermented using a dry-grind method. These varieties were reported previously to have significantly different field performance and physico-chemical properties. Fermentation profile of most varieties was similar, with a lag phase in the first 12 hours, followed by an exponential phase till 60-80 hours and finally a stationary phase. Fermentability of all varieties was in the range of 87.3-89.1%. Final alcohol content was strongly correlated to seed protein content (R^2=0.6563), but weakly correlated to starch content (R^2=0.3111), glucose content (R^2=0.2407) and whole grain gross energy (R^2=0.2926). Yeast assimilable nitrogen content was not correlated with fermentation rate when comparing different sorghum varieties. The outcome of this study enables systematic comparison of Australian sorghum for alcohol production and paves the way for further study into solid state fermentation of sorghum under simulated conditions for *Baijiu* production.

6B.5

CHARACTERIZATION OF ANTIOXIDANT ACTIVE PHENOLIC COMPOUNDS IN SORGHUM GRAINS USING UHPLC-ONLINE ABTS AND LC/MS QTOF

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Phenolic composition and relative antioxidant activity were investigated in six varieties of sorghum including pigmented and non-pigmented pericarp varieties. Whole grain sorghum extracts were subjected to acidified acetone extraction and were analysed using UHPLC with an attached online ABTS system and Q-TOF LC/MS. Results showed that the black pericarp variety Shawaya short black 1 and the brown pericarp IS11316 had the highest total phenolic content (TPC) and total proanthocyanidin content (TPAC), consequently resulting in overall high antioxidant activity. The phenolic compounds that had the highest antioxidant activity in Shawaya and IS11316 were catechin, 1-O-cafferolglycerol-O-glucoside, taxifolin and pentahydroxyflavanone-(3->4)-catechin-7-O-glucoside. Furthermore, comparison of the phenolic profiles has shown that the varieties with higher antioxidant activity generally had higher quantities and more diverse range of polyphenols. Thus this study indicates that there is no single compound in sorghum that results in its high antioxidant activity but rather it is the cumulative effect of various phenolic compounds.

7A.1

MEASUREMENT OF STARCH AND STARCH FRACTIONS

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In this study, we describe an assay format that allows the measurement of Rapidly Digested Starch (RDS), Slowly Digested Starch (SDS), Total Digestible Starch (TDS), Resistant Starch (RS) and Available Carbohydrates (AVCHO) from the one incubation experiment. The procedure for determining RDS and SDS are according to the method described by Englyst *et al*., (1992), but considerably simpler to perform. Enzymes employed are in a purified, ready-to-use form and removal of samples during incubations are simplified. The procedure also includes a value for TDS from a sample removed from the incubation after 4 h, generally considered to be the approximate time of residence of food in the human small intestine. With this sample, measurement of available carbohydrates is enabled by including hydrolysis of sucrose by sucrase and lactose by □-galactosidase, with measurement of glucose and fructose. In this context, available carbohydrates are defined as the sum of glucose and fructose released on hydrolysis of non-resistant starch, maltodextrins, sucrose and lactose, together with free glucose and fructose. Resistant starch is obtained by removal of 4 mL of stirred incubation solution after 4 h with addition of this to an equal volume of ethanol and recovery, dissolution and hydrolysis of the resistant starch and measurement as glucose.

In recent years, the accuracy and reliability of AOAC Method 996.01 for total starch has been questioned. It has been stated that under the hydrolysis conditions employed for dextrinisation of starch with α-amylase (pH 7) there is some isomerization of terminal, reducing-end D-glucosyl residues of maltodextrins to fructose, leading to incomplete hydrolysis by amyloglucosidase and thus underestimation of the starch. Other factors such as required incubation time with α-amylase and linearity of the GOPOD/glucose standard curve have also been challenged. In this presentation, each of these concerns has been studied, and an even simpler format for total starch determination has been developed.

7A.2

NEW METHODOLOGY FOR SELECTING GRAINS FOR IMPROVED PROPERTIES

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Amylose molecular structure is an important parameter controlling many properties of starch-based foods, such as pasting and sensory qualities. Although it is sometimes thought that amylose is a linear glucose polymer, in fact it has a small but significant number of long-chain branches. It is well known that amylose content is an important property-controlling parameter, but it is by no means the only one. Just to give one example, cooked rices with similar amylose content can have significantly different sensory properties (particularly stickiness and hardness). Recent studies (e.g. H Li et al., Scientific Reports 7 43713 2017) have shown that many functional properties are also controlled by amylose fine structure (the chain-length distribution, CLD, of the debranched starch), plus properties such as the fine structure of the amylopectin and (in the case of cooked rice) the total size distributions of both amylose and amylopectin which are solubilized during the cooking process, as well as non-starch components. Determining the CLD of amylose has previously been a major problem. The best method for this is size-exclusion chromatography (SEC, a type of GPC) of debranched starch, which shows that usually the amylose CLD has two or more distinguishable regions (although this requires good SEC separation for reproducible results). However, SEC suffers from the problem of band broadening, which smears out fine features. Recently (Nada et al. Analytical & Bioanal. Chem. 409 6813 2017), a method has been derived to overcome this problem, which reduces the amylose CLD to a small number of biologically meaningful parameters. When this is combined with a method for doing the same with the amylopectin CLD (AC Wu et al. PLoS ONE e65768 2013; Biomacromolecules 11 3539 2010), and average molecular sizes of whole molecules (parent and leached) from SEC, together with information about non-starch components such as proteins where relevant, a statistical treatment has been developed to find causal relations between molecular structural parameters and desired functional properties. This will be exemplified with choice of barley grains for optimal brewing properties, and cooked rice varieties with both improved digestion rates (slow digestion being desirable) and acceptable palatability. This is by choosing grain varieties with CLDs and other parameters in optimal ranges suggested by the statistical analysis.

7A.3

TESTOGRAM, HAGBERG FALLING NUMBER MEASUREMENT IN 90s

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Pre-harvest sprouting or germination on the mother plant (due to rain before harvest) and late-maturity alpha-amylase (due to heat or cold shock during grain development) cause alpha-amylase activity increase. The consequences of this for wheat flour and baked products can be very important and may lead to significant problems like sticky dough, bread with low volume and excessively red crust. The Hagberg falling number method was developed in the early 1960's to provide a rapid means of determining the alpha-amylase activity. This widely accepted method measures the time required for a sensor to plunge into a heated flour and water gel. Alpha-amylase present in the gel will cause it to degrade and reduce the viscosity of the gel. Thus, the plunger will fall faster. The shorter the time required for the plunger to fall indicates higher levels of alpha-amylase. The conventional FN machine (Perten Instrument) uses breakable glass tubes, boiling water and a cooling tower. A new device, Amylab FN (Chopin Technologies) using a safer induction heating system and reusable test tube made of aluminum is now available. This new device presents a new protocol named Testogram. The instrument measures the viscosity with a built-in sensor, during 90s of shaking. The objective of this study is to evaluate accuracy performances of this new machine. 184 white wheat flour samples covering a wide range of alpha-amylase activity (from 100 s to 450 s) are analyzed both with the new Amylab FN, testogram protocol and with the Perten FN machine. The observed correlation coefficients (r^2) between the two machines are equal to 0.99. In the same way, the difference between the two machines is lower than the uncertainty of ISO 3093 method for more than 95% of the tested samples. This study confirms the Amylab FN ability to provide equivalent results to conventional machine with safer and more user-friendly conditions.

7A.4

VISUALISING MICRONUTRIENT DISTRIBUTION AND MOBILISATION IN GERMINATING RICE GRAINS

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Determining the spatial distribution of micronutrients in germinating rice grain is important in understanding the mechanism of resource mobilisation during plant growth and development. Most techniques to quantify micronutrients involve destructive chemical analyses which cannot provide information on suborganelle localisation. In this study, the *in situ* spatial distribution of micronutrients in germinating rice grains was determined using x-ray fluorescence microscopy (XFM) using the Australian Synchrotron facility. Results revealed that Zn, Mn, and Fe are present in high concentrations in the aleurone layer; while Si, Ca and Cu are more evident in the hull. P and S are present in actively growing tissues, with K and Cl very pronounced in developing roots and shoots. Simultaneous display of three elements using RGB mode revealed evidence of mobilisation of Zn, and to a lesser extent, Fe from the aleurone layer to the embryo. In addition, root uptake of iodine during germination has been successfully demonstrated in setups where germinating rice grains were spiked with potassium iodide. Lastly, there was no evidence for the presence of Cr, Ni, Ge, or As in the germinating rice grains tested. In summary, these results demonstrate that high-resolution *in situ* XFM is a very powerful technique for the simultaneous detection, quantification and spatial distribution profiling of elements in germinating Nipponbare and Pokkali rice grains. These results provide an exciting area for future research to deeply understand the molecular mechanisms governing micronutrient mobilisation in germinating and even in developing rice grains.

7A.5

ASSESSING RHEOLOGICAL PROPERTIES OF STARCHES AND HYDROCOLLOIDS IN HIGH TEMPERATURE CONDITIONS

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Large-scale high temperature food processes are becoming an industrial standard for cooking, sterilisation, and rheological purposes. Most ingredients suffer from thermal degradation and thus exhibit substantial differences in rheological property at temperatures above 100°C. Knowledge of the processing potential and stability of the ingredient under various heat and shear conditions can help formulators better assess ingredient suitability, as well as reduce cost through formula optimisation. Perten Instruments has recently launched the Rapid Visco Anlayser (RVA) 4800 that can perform regular tests below 100°C, as well as high-temperature tests up to 140°C in a specially designed pressure vessel. Various starches, hydrocolloids, and starch-hydrocolloid composites were assessed on the RVA 4800 at 95°C, 121°C, and 140°C using a shear loop profile. The synergy between xanthan and the galactomannan locust bean gum was stronger and more thermally resistant than with guar gum. Addition of xanthan-guar and xanthan substantially increased the viscosity of starches at 140°C. Different batches of the same hydrocolloid were found to be inconsistent, exhibiting opposing rheological behaviour at various test temperatures. Of the starches, the high-amylose starch exhibited greater viscosity recovery at higher temperatures; the highly cross-linked starches showed better thermal resistance than the low cross-linked starch; and modified starches showed better viscosity recovery than native starches. By emulating high temperature food processes, the RVA 4800 served as a useful tool for assessing the rheological behaviour and process suitability of hydrocolloids, starches, and their composites.

7B.1

APPLICATION OF HIGH-THROUGHPUT IMAGE ANALYSIS TO QUANTIFY PULSE QUALITY TRAITS

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Unprocessed pulse grains are predominantly assessed for quality based on their physical and visual attributes. These include seed-size and colour, seed-shape, and deformities due to genetic or abiotic effects. Processed pulse grains (dehulled and split) are assessed for cotyledon colour, damaged cotyledon and poor milling quality based on hull-adherence to the cotyledon. Within plant-breeding programs and for grain-trading, many of these seed traits are determined by time-consuming methods such as sieving to determine seed-size distribution and foreign seeds or assessed visually in the case of seed-coat colour and seed-damage. Due to the intrinsic nature of these seed traits many are determined subjectively and, as a result, inconsistencies can occur in classifying quality-grades or market classes.

Machine vision methods, incorporating 2-dimensional imaging systems, are commonly used for objective seed grading. However, the absence of data for the third dimension (seed height) is a limitation in determining seed deformities arising from mechanical damage during harvest, or due to biotic and abiotic effects during the plant-growth stage.

Using the Foss, EyeFoss instrument, multispectral digital images coupled with seed surface-height images (captured simultaneously by laser), were collected for individual pulse grains travelling on a conveyor system. These images were subsequently used in the development of algorithms to determine characteristics of the seed size, shape and surface. Predictions of seed diameter, volume and mass as well as seed-size distribution were derived through image analysis of both the colour and height-contour images. Multispectral images gave the ability to determine seed-coat colour and defects utilising colour intensity values across the full visible spectrum. This image-based testing has been applied within the lentil and field-pea breeding programs, contributing to increased efficiencies within the quality assessment laboratory as well as streamlining plant-breeding strategies.

7B.2

PRODUCTION AND CHARACTERIZATION OF READY-TO-EAT CHICKPEA FLAKES

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Pulses are a food of global significance due to their high protein and dietary fiber content. Pulse consumption is below recommended levels in developed countries and is also declining in developing nations. Pulse flakes are currently only present in the ready-to-eat (RTE) market as niche products, but could be a means of increasing pulse consumption if the challenges of their structural weakness and long cooking times can be overcome. In this research the influence of processing conditions on the flaking behavior and physicochemical properties of Australian chickpea splits was investigated on a pilot scale flaking line. Chickpea splits were first precooked for six minutes with different steam injection times (one, three or five minutes). The precooked splits were then passed through a roller flaker with different roller gaps ranging from 0.6 - 1.9 mm and the pulse flakes were finally dried using a fluidized bed drier at either 150 or 200°C. The hard-brittle splits, through the heating and live steam injection, transitioned to a rubbery state that were flaked successfully. Moisture content and hydration properties were determined gravimetrically and differential scanning calorimetry was used to evaluate the degree of starch gelatinization and protein denaturation. Flake hardness was evaluated using a texture analyzer and flake structures investigated using scanning electron microscopy. Starch gelatinization increased with steaming time, while protein denaturation was not significantly affected. Cellular structures were conserved in the flakes produced and flake hardness was negatively correlated to steaming time. Successful production of chickpea flakes offers opportunities for the production of healthy, high-protein high-fiber RTE foods.

7B.3

IMPROVING BAKING QUALITY OF LUPIN-WHEAT BREADS THROUGH ADDITION OF DRIED GLUTEN

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The incorporation of lupin flour into bread is an area of interest due to the health benefits this offers to consumers. Lupin flour has high fibre content, very low starch content, and although high in protein, does not contain gluten. Both gluten and starch play important roles in bread quality. The gluten network developed during mixing allows loaves to expand during proofing through the capture of CO_2 released by yeast activity, resulting in good loaf volume. In the oven, starch granules swell adding further to loaf expansion and then set as partially gelatinised granules embedded in the gluten matrix giving rise to soft and springy crumb texture. Through the diluting effect on wheat gluten and starch, lupin enriched bread typically results in reduced loaf volume and coarser, firmer crumb texture. A higher water requirement resulting from increased fibre content leads to sticky doughs that can be difficult to handle, especially in mechanised processes. These limitations have led many researchers to optimise lupin incorporation at levels of only 5% to 10%. To better enable consumers to obtain the benefits offered by inclusion of lupin in the diet, bread inclusion rates of 20% are more desirable. The present study aimed to investigate if the addition of powdered gluten could improve loaf quality produced from 20% lupin enriched wheat flour. Addition rates of 2, 3.5 and 5% were compared to nil addition and also to a wheat flour only control. Effect of lupin source was explored through use of flours from both white lupin (*Lupinus albus*) and Australian Sweet Lupin (*L. angustifolius*); and performance evaluated in two different baking systems (rapid and sponge & dough) to determine effect of processing conditions. Significant improvements in loaf volume and crumb texture were observed: compared to nil addition, 5% gluten increased loaf volume by an average of 20% across lupin sources and baking methods, and crumb softness by 30 to 50%.

7B.4

BLENDING STUDIES USING WHEAT AND LENTIL COTYLEDON FLOUR – EFFECTS ON RHEOLOGY AND BREAD QUALITY

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Lentil (*Lens culinaris*.) is a highly nutritious food staple widely consumed within India and the Mediterranean and although gaining popularity in western diets, wheat (*Triticum aestivum*) will continue to be a major crop as it can be used to manufacture a wide range of products. The nutritional benefits of lentils are acknowledged, particularly as a source of high protein so the incorporation of lentil flour into wheat-based foods has the potential to improve the nutritive value of a range food products. Blending lentil and wheat flour improved the nutritional quality of bread. Optimising the blending ratio limited the deleterious effect on rheological properties resulting in acceptable loaf volume and crumb structure.

7B.5

THE POTENTIAL OF LUPIN AS A FUNCTIONAL FOOD FOR THE PREVENTION OF DIABETES AND PANCREATIC CANCER

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In Australia, lupin has until relatively recently been used solely as a feed stock and for soil nitrogen replenishment. With the world demand for nutritious plant-based foods for human consumption continually increasing, and more especially in the light of pulse crops for the export and domestic markets, it is appropriate to evaluate lupins for both safety and functional characteristics. We examined the chemistry and some biological activities of the seed coats (methanol extract) and de-hulled lupin flours (trichloroacetic acid [TCA] extract) of six cultivars of *Lupinus angustifolius* and three cultivars of *L. albus*. Five of the seed coat extracts (two *L. angustifolius* and three *L. albus*) were found to induce apoptosis in MIA PaCa-2 (human pancreas carcinoma). All 6 *L. angustifolius* seed coat extracts inhibited α-glucosidase action *in vitro*. The TCA extracts contained quinolizidine alkaloids at levels below human toxicity but with potential health benefits. Human studies which have reported some of these alkaloids as possessing 'antidiabetic' activity. In all, our results support the notion that lupin is potentially a nutraceutical and functional food of note.

9A.1

STATUS AND TRENDS FOR THE DEVELOPMENT OF SCIENCE AND INDUSTRY OF CEREAL-BASED FOODS IN CHINA

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China has become one of the five most important economies in the world. China's agriculture has achieved a historic breakthrough, feeding now 23% of the world's population with 8% of the world's arable land. The total production of main farm products has risen to the top of the world and the output of food grain has reached 500 million tons. For the past five years, total industrial processing of agricultural products has had a yearly average increase rate of 10.8%, of which food processing accounts for 42% with an average yearly increase rate of 15%. There are over 600,000 farm product-processing enterprises, employing 16.08 million people. In particular, the grain processing industry which is the mainstream food industry in China, plays a critical role in this booming market. Besides production, China is a major country in terms of consumption. Wide varieties of ethnic, frozen, bakery, convenient, and other cereal-based foods are consumed annually. Significant changes have taken place since the reform and opening up to the world in consumption patterns and market trends, for example, chain-store operations, which has stimulated the development of food processing technology. This presentation will show how the application of underpinning science and technology is used to understand the contribution of new ingredients and processing methods in the industrialization, standardization, and optimization of quality for a range of traditional food products, such as steamed bread and Shao Bing (local pastries) etc. Development trend in the use of filling-containing frozen dough technology, "nature yeast" technology, and modern sourdough technology in China will be presented using specific examples. From the international trade standpoint, China's current grain situation, and her practices of stabilizing grain prices, gaining the balance between supply and demand, and ensuring domestic grain security will be discussed. This presentation will indicate that while the underpinning grain science may be global, its application requires a sound knowledge of local products and their associated manufacturing and consumer preference bases for millers, bakers, ingredients players or traders to remain successful in the era of economic globalization.

9A.2

OPPORTUNITY FOR AUSTRALIA TO SUPPLY SOFT WHEAT FOR CAKE AND BISCUIT APPLICATIONS IN ASIA

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North American soft wheat currently dominates the growing Asian cake and biscuit markets. Asian mills are looking for alternative soft wheat supplies to avoid concentration risk associated with a sole source of supply from North America. One of the objectives of this project is establishing the functional suitability of Australian Noodle Wheat 2 (ANW2), Australian Standard White (ASW) and Australian soft (ASFT) for cake and biscuit uses in Asia. This will provide opportunities for Australian growers to realise increased values by becoming an alternative supplier. Technical exchange with Japanese and Indonesian mills suggested that ANW2 and ASFT have potentials to meet Asian mill quality expectations for cake and biscuits.

9A.3

FORTIFICATION OF PASTA WITH WHEAT BRAN PROTEIN CONCENTRATE

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Pasta products are regarded as a staple food with an annual consumption worldwide of 3 million tonnes and increasing. However, these products are deficient in some essential amino acids. In this study wheat bran protein concentrate (WBPC) was isolated from durum wheat bran using alkaline extraction at pH 9 and isoelectric precipitation at pH 4 to supplement spaghetti at levels 1 and 5% (w/w). Our results showed significant changes in chemical composition of fortified spaghetti in terms of protein content and fat. Phytosterol content of fortified spaghetti increased with increasing level of WBPC addition. Spaghetti cooking quality (firmness, stickiness, color, cooking loss and water absorption) were determined. Firmness increased with increasing level of addition of WBPC while stickiness and cooking loss showed no differences between control and fortified spaghetti while color was significantly darkened by increasing WBPC. From these results it appears that WBPC is a promising material to enhance the nutritional value of pasta products without significant negative changes in cooking properties and provides an alternative use of the low value bran milling stream.

9A.4

SENSORY EVALUATION OF CHINESE WHITE SALTED NOODLES AND STEAMED BREAD MADE WITH AUSTRALIAN AND CHINESE WHEAT FLOUR

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Background and objectives: Chinese white salted noodles (CWSN) and steamed bread (CSB) are staple foods and represent approximately 65% of wheat consumption in China. Sensory evaluation was used to measure the quality attributes of selected Australian wheat varieties and Chinese commercial wheat for Chinese white salted noodle and northern style steamed bread. Descriptive parameters for Chinese sensory evaluation are described and tested using a Chinese trained expert sensory panel.
Findings: The results showed that flour from selected Australian wheat varieties had better gluten properties, dough mixing characteristics and starch properties compared with commercial Chinese wheat flour. Improved sensory evaluation scores in noodle firmness, stickiness, elasticity, smoothness and flavour resulted in a significantly higher total quality score ($p<0.05$) for all Australian wheat flours and blends (60% and 74% extraction) compared to the two Chinese wheat flours. Sensory evaluation scores for steamed bread from the Australian wheat variety Mace (60% and 74% extraction) were equal to the best Chinese gold standard flour (49% extraction) and significantly higher ($p<0.05$) than Chinese flour of 69% extraction. The Australian flours with protein content 9-10.5% produced higher quality white salted noodles and steamed bread than the higher protein 12.0% Chinese flours. The highest scoring noodles at 78.5 to 79.5 points were Australian Mace, and Mace and Zen blends. The highest scoring Chinese steamed bread at 85.7 points was Mace at 60% extraction.
Conclusions: The features of the Australian 60% extraction flours were higher noodle firmness, elasticity and smoothness scores, and improved flavor compared with the 49% extraction Chinese gold standard flour. Noodle sensory evaluation results showed significantly higher total scores compared with noodles made with the two high quality Chinese wheat flours. The features of Australian 60% extraction flour were ideal for steamed bread mouthfeel; stickiness, texture and elasticity/firmness. Steamed bread made from Mace flour (60% and 75% extraction) showed a significantly higher total score compared with steamed bread made from Chinese wheat flour (69% extraction). The demand for improved wheat quality in China is growing.
Significance and novelty: This research contributes to defining sensory quality testing methods and quality characteristics for Chinese noodles and steamed bread. Mace and Zen blends were tested for sensory quality by a Chinese expert sensory panel.

9A.5

DISTRIBUTION OF DIFFERENT ENZYMES IN THIRTEEN MILLING FRACTIONS OF SPRING WHEATS

Farhan Saeed and Muhammad Nouman

The proposed work was carried out to extract enzymes in different milling fraction of wheat followed by the effect of milling on enzyme distribution. For this purpose, two varieties of wheat were procured from Ayub Agriculture Research Institute (AARI), Faisalabad. The study comprises of three main phases. For this purpose, physical characteristics of wheat grain like test weight, thousand kernel weights, were probed according to their respective methods. After physical characterstics, wheat was milled through Moore Roller Flour Mill and the flour of different streams were analyzed for the proximate composition and falling number according to AACC methods. Results showed that highly significant, significant and non-significant variations were expounded in physico-chemical analysis of different spring wheats and their mill streams. Moreover, falling number showed highly significant variations among varieties and different mill streams, mean values varied from 290-325 sec. in whole wheat flour, 240 to 371 sec. in different mill streams respectively. It is evident from the analysis that alpha amylase, protease and peroxidase activity was highly significant among wheat varieties and different mill streams. Mean values of alpha amylase varied from 3.98-4.43 units/g protein in WWF and 2.21 to 5.99 units/g protein in different mill streams, for protease values was varied from 163.33 to 167.42 units/g protein in WWF and 2.15 to 443.93 units/g protein in different mill streams, At the end mean value of peroxidase varied from 2425 to 2565 units/g protein in WWF and 722.0 to 3762 units/g protein in different mill streams respectively. Conclusively, it is evident from whole research that obtained results regarding presence of enzymes in different wheat varieties and their mill streams will be beneficial for preparation of blends either by omitting the particular streams for the preparation of enzyme extraction and used in different products.

9B.2

THE EFFECT OF GENOTYPE AND ENVIRONMENT ON QUALITY PARAMETERS IN AUSTRALIAN CANOLA

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Canola breeding programs in Australia have significantly enhanced canola as an oilseeds crop, and it is firmly established a part of the crop rotation in many areas. While current breeding programs have improved oil content, yield and disease resistance, there has been minimal focus on oil or meal quality. End- users have different requirements when utilising canola oil and meal. The fatty acid composition and antioxidant concentration in canola oil can have a significant effect on the stability of the end product. While canola meal is used as a protein source in animal feed rations, other quality parameters such as digestibility and available energy are important considerations when developing the rations. The aim of this research was to determine the level of the quality parameters in *Brassica* genotypes, and the effect of genotype (G), environment (E) and genotype x environment (GxE) on these parameters. Laboratory analysis was conducted on field trials to determine the relative levels of the quality components in the oil and meal. It was found that most quality components in oil and meal are significantly affected by G, E and GxE. Correlations were found to exist between some of the parameters; therefore these relationships should be taken into consideration when breeding for quality traits.

9B.3

ADDING VALUE TO CANOLA MEAL: PREPARATION OF HIGH PROTEIN MEALS

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Canola meal has the potential to be an alternative protein source for human consumption due to its high biological value, high protein efficiency ratio and balanced amino acid composition. It also has good potential to confer technologically functional properties for performance as a viable food ingredient. However, the high production cost of canola proteins may be an issue. Large scale commercialisation of canola proteins has not been successful despite the extensive research and attempts for realization of canola proteins for food industry. Canola meal as a source of protein is currently underutilised. Canola meal contains approximately 40% proteins and is mainly used as cattle feed. Higher market value aquaculture feed has a much higher protein content (60-65%). A processing method has been developed to increase the protein content of canola meal to more than 60%, while maintaining its high protein digestibility. Additionally, the processed canola meal has an enhanced amino acid profile, but reduced levels of dietary fibre and anti-nutrients. The production cost of this high protein meal is much lower than the average market price of fishmeal, making it a commercially viable and attractive contender in aquaculture feed market. Development of high protein meal for aquaculture feed has the potential to increase profitability of the canola production and processing industries.

9B.4

DOES CRUDE OIL EXTRACTION TECHNIQUE AFFECT CANOLA OIL FUNCTIONALITY?

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Crude oil extraction technique can affect the physicochemical properties of canola oil. However, the effect on refined canola oil is not well studied. This study investigated the frying characteristics of two refined canola oils obtained by two extraction techniques – mechanical-pressing (MCO) and solvent-extraction (SCO). Refined canola oils from both extraction techniques were obtained from Australian processors and used to fry potato chips. Differences in frying functionality of the oils were assessed by monitoring oil degradation indices total polar materials, tocopherols degradation and changes in the major fatty acids oleic, linoleic and linolenic acids. The refined canola oil from mechanical-pressing exhibited better frying stability than the refined oil from solvent-extraction. The frying life was correlated with tocopherols degradation during frying with greater tocopherols loss correlating with reduced frying life. The differences in canola oil frying performance most likely resulted from differences in crude oils obtained by the two extraction techniques which effected changes in the refined canola oils. Also, process variations as applied by the different processors can affect refined oil quality, hence canola oil functionality. The result of this study could serve as a platform for optimisation of existing processes to produce canola oils with better functionalities.

9B.5

INCREASING SEED OIL CONTENT OF *BRASSICA NAPUS*

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In the next 15 years, global vegetable oil production needs to increase by almost 50% to meet the increasing demands from an increasing population. However, only about one third of the global land area is actually available as agricultural land. There's a need to improve the productivity of our current crops and use our agricultural land to its maximum potential. Some of the well-known oil seed crops including soybean, sunflower and canola. These crops together contribute over half of the global production of vegetable oil, with canola alone contributing almost 20% of total production. However, oil production in these crops is limited to the seeds, which accounts for only a very small portion of the plant. To increase global oil production, one strategy is to increase the oil content of oilseeds. To achieve this, we need to re-engineer the metabolism of the seeds. There are many different approaches to consider for achieving this, including the reduction of protein or carbohydrates, or optimising those pathways directly involved in driving the production of oil. These approaches could be either implemented alone or in combinations. With *Brassica napus* as an example, we have demonstrated seed oil content increases of greater than 6% by a combination of strategies. This provides insights into what could be achieved in other oilseed crops, in steps towards addressing global vegetable oil demands.

10A.1

INNOVATIVE PART-BAKED BREAD WITH IMPROVED NUTRITIONAL VALUE

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Customer demand for high quality and healthy foods brings about innovations in bread industry leading to development of various types of multi-grain and high-fibre breads. Although part-baked bread is a popular and established technology, it mostly focuses on production of white bread with limited knowledge on the effects of fibre and nutrients on the quality of the full-baked breads. This research shows the results of applying different strategies to improve the nutritional quality of part-baked bread and to preserve the quality of the end products which might be of interest to the bread industry. Oat flour as a rich source of dietary fibre and bioactive compounds and lupin flour as a main source of protein and fibre were used in production of part-baked breads. In addition, symbiotic part-baked bread was produced by inclusion of heat stable *Bacillus Coagulans* (*GanedenBC* 30) as a probiotic and inulin as a prebiotic. Increasing the flour substitution level with oat and lupin flour affected dough water absorption, rheological and pasting properties. Reduced specific volume and unpleasant taste, increased bread hardness, colour changes and higher rate of staling for 72 h were the undesirable effects of oat flour inclusion in particular at substitution levels greater than 30%. Part-baked lupin bread containing 20% lupin flour required addition of 3.5% gluten powder to retain its quality in terms of volume and texture. Symbiotic part-baked bread was successfully produced exhibiting excellent viability of probiotics (>10^6 CFU/g) even after storage for three days at ambient temperature. Increasing the level of inulin from 2.5 to 7.5% had no significant effect on the viability of probiotics and preserved the freshness of the stored bread for 72 h, however, higher levels of inulin had negative effects on bread volume and firmness. Therefore, inulin content should be optimised based on the bread quality attributes and customer study as well as the viability of the probiotic bacteria.

10A.2

QUALITY ASSESSMENT OF AUSTRALIAN OAT VARIETIES AND THEIR PERFORMANCE IN PROCESSING ASIAN OAT PRODUCTS

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Demand for oat grain for human food is increasing globally due to its health benefits. Sophisticated Asian health markets are now focusing on innovative oat-based food products other than oat flakes. Australia is one of the main oat exporters, particularly to the Chinese market. The objective of our study was to evaluate the quality characteristics and performance of Australian milling oat varieties (Bannister, Dunnart, Mitika, Williams, Wombat, Yallara, Durack and Kowari) from four locations grown over two years (2015, 2016) when processed into Asian oat products (oat-noodles and oat-rice). Compositional variations of oats were noted between the years and varieties with the cooler and wetter year (2016) having lower total starch, protein, β-glucan and higher lipid and total dietary fibre content. Oat flour pasting peak viscosity and final viscosity were positively correlated to 51% oat-wheat noodle cutting (firmness) and some compression textural parameters with Mitika, Yallara and Wombat having significantly highest resilience and recovery to compression. For oat-rice (pearled oats) it was noted that pearling time was influenced by physical properties of groats (Hardness Index, roundness, shell collapse time) with Dunnart, Bannister and Yallara oat cultivars having the shortest pearling time to achieve standardised bran loss. Results indicate significant varietal and environment influence on oat quality and oat product performance.

10A.3

CHARACTERIZATION OF BRANCHED LIMIT DEXTRIN AND IMPACT ON STARCH RETROGRADATION PROPERTIES

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Some alpha-amylases and beta-amylases are well-known to have an anti-firming effect on bread. It has been found that the low-molecular-weight dextrins produced during starch hydrolysis by alpha and beta-amylases can interfere with starch retrogradation and thus reduce the rate of bread firming. However, it is still unknown whether starch hydrolyzate with different molecular weight and molecular structure would have the same anti-aging effect. Branched limit dextrin (BLD) is composed of a linear chain of alpha-(1, 4)-linked D-glucose residues connected through alpha-(1, 6) glycosidic linkages, which could be produced by starch hydrolysis mediated by alpha- and beta-amylases. Unlike other low-molecular-weight dextrins, BLDs have the original inner core structure with branched chains. In this work, BLDs were prepared by hydrolysis of starch by alpha- and beta-amylases and subsequent ethanol precipitation into fractions of different molecular weights and structures. The characterization of BLDs was done using matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF-MS) and ^{1}H nuclear magnetic resonance (^{1}H NMR) spectroscopy. The average molecular weights of BLDs from both corn and waxy corn starches decreased upon an increase in ethanol concentration from 70% to 90%, that is, from 1918.30 to 1274.23 and from 1938.11 to 1356.35, while the ratio of alpha-(1, 4) to alpha-(1, 6) glycosidic linkages increased from both corn (from 5.27 to 8.46) and waxy corn starches (from 3.80 to 4.62). The effect of branched limit dextrins (BLDs) on the retrogradation properties of corn and waxy corn starch was investigated using differential scanning calorimetry (DSC), wide X-ray diffraction (WXRD). The DSC data showed that the retrogradation of corn and waxy corn starch were retarded by BLDs. The BLD with the lowest molecular weight had the best influence on corn and waxy corn starch retrogradation. The result of WXRD confirmed it. Avrami equation was used to analyze the enthalpies of retrograded corn and waxy corn starch. Starch recrystallization rate (k) reduced with the addition of BLDs, indicating that BLDs reduced the kinetics of starch retrogradation.

10A.4

UNDERSTANDING PROTEIN DEGRADATION DURING MALTING AND MASHING TO IMPROVE BARLEY MALT QUALITIES

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Barley protein contributes to malt qualities in many ways. Australian Malt1 barley grain protein receival standards set a minimum 9.0% and 9.5% in eastern and Western Australia, respectively, while the preferred protein level is 10%-11.5 % in Chinese malting and brewing industries. Low protein barley can be a challenge in competitive international malt barley markets. We are investigating protein degradation during the malting processes to improve malt qualities of Australian barley. Barley grain protein is converted to fermentable free alpha amino acids (FAAN) and small peptides during malting and mashing. Fermenting yeast require certain types of amino acids for growth. Malt proteins are also found in beers, which contribute many properties including flavour, foam formation/stability and shelf-life. Malting and mashing processes can't completely convert all grain proteins to fermentable FAAN; normally about 50% of the grain proteins are discarded in spent grain therefore not all malt protein can be utilised by breweries. We have studied the protein degradation processes during malting and mashing to help identify efficient utilisation of grain proteins. The results suggest that protease activities in malt extracts assayed with available enzymatic methods are not the main determinants for generating FAAN. However, it was shown that major genes for soluble proteins are present on barley chromosome 5H, which controls not only soluble protein contents, but also other malting qualities such as dormancy, alpha amylase and malt extracts. A couple of potential control genes were identified underlying these traits. By analyzing RNA-Seq data generated from developing grain and germinating seeds, it was showed that expression of the control factor genes was highly correlated with the expression of some protease inhibitors. Analysis of the RNA-Seq data also revealed that the mRNA of these protease inhibitor genes was most abundant during seed development which indicates their importance in grain development. Degradation and removal of these protease inhibitors becomes very critical during seed germination for the efficient recycling of storage nitrogen. We have also studied the wort protein compositions by 2D PAGE and ultra-high-performance liquid chromatography coupled to high resolution time of flight mass spectrometer (UPLC-Q-TOF). The analysis of abundant protein species showed that different barley varieties generated different protein profiles in wort, while protein modifications such as glycosylation might play key roles in the wort protein contents.

10A.5

MODIFICATION OF BARLEY DIETARY FIBRE THROUGH THERMAL TREATMENTS

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The present research was carried out to observe the effect of different thermal treatments on dietary fibre ratio to improve functional properties of barley. For the purpose, two varieties of barley i.e. Haider-93 and Jau-87 were procured from Ayub Agriculture Research Institute (AARI) Faisalabad-Pakistan. In 1st phase, barley varieties were milled and then wet and dry heat-treated through different ways including boiling, pressure-cooking and roasting according to their respective methods. In 2nd phase, barley varieties were firstly soaked and then cooking of soaked and non-soaked barley was performed. Moreover, canning of both barley varieties was also included in this phase. Results showed that untreated barley contains more insoluble dietary fibre (12.00-12.40 g/100g dm) than soluble dietary fiber (4.73-5.70 g/100g dm). Additionally, it was revealed that in 1st phase, the modification of soluble (13.32%) and insoluble dietary fibre (8.79%) ratio through pressure cooking was non-significant whilst roasting showed significant results i.e. 53.91% increase in soluble dietary fibre and 8.79% decrease in insoluble dietary fibre. In 2nd phase, cooking without soaking gave highest results i.e. 68.08% increase in soluble dietary fibre and 15.48% decrease in insoluble dietary fibre. It was concluded that among all treatments of phase I and II, the better results were shown by cooking without soaking.

10A.6

CHARACTERIZATION AND NUTRITIONAL PROFILING OF POTATO PEEL BLENDED COMPOSITE FLOUR WHEAT COOKIES

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This study was carried out to evaluate the nutritional profile of potato peel and effect of wheat flour replacement with potato peel powder on the physic-chemical attributes of potato peel composite flour cookies. Potato peel showed to contain negligible fat contents, 6.20 ± 0.20% protein, 5.26 ± 0.20% ash, 12.4 ± 0.40% crude fiber and 8.20 ± 0.27% moisture of total weight, while total phenolic and flavonoid contents 4.5 mg/gm and 4.5 mg/gm respectively. Moreover, Potato peel showed higher water and oil absorption capacities compared to wheat flour. Then potato peel composite flour cookies were produced by replacing 3% in T_1, 6% in T_2, 9% in T_3, 12% in T_4 and 15% in T_5 wheat flour with potato peel powder. The results showed significant difference among treatments for moisture, fiber, protein, ash, phenolic contents and antioxidant activity. Finally, potato peel composite flour cookies were subjected to sensory analysis the control group obtained maximum hedonic scale scores 8 followed by T_1, T_2, T_3, T_4 and the lowest in T_5.

10B.1

FUTURE TRENDS – THE CONSUMER OF THE FUTURE

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There have been large changes over the last 100 years in food choices and demand characteristics. Most of these changes have been slow and relatively predictable, until now. More recent changes are kick-starting a revolution that will see demand characteristics change markedly, and rebalance the power toward the consumer. It will be more important than ever to be genuinely consumer driven in product development, and to understand these changes when deciding what to grow, produce and then how to market foods. This talk will briefly review the history of food choices and lead into a discussion of findings from multiple experiments and surveys over the last 12 years to predict the demand characteristics for grains over the next 10 years and beyond. The overview nature of this presentation will set the scene for the more specific talks that follow in this session – Future Trends.

10B.2

BUILDING STRONGER WHEAT MARKETS IN SOUTH EAST ASIA

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Under intense competition from alternative supply options, Australian wheat exports have shifted from the Middle East to South East Asia. Similar competition is now placing pressure on Australian wheat exports to key markets including Indonesia and Malaysia. Effective market intelligence and development is required to support Australia's share of value in the SE Asian wheat market. This paper will present progress on key activities to defend Australia's share of value in the South East Asian wheat market.

10B.3

UNDERSTANDING LENTIL CONSUMERS IN INDIA: CONSUMER BEHAVIOUR, LIKELY FUTURE DEMAND, AND ATTITUDES TO AUSTRALIAN LENTILS

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Lentil plays an important role in food and nutrition security for millions of people in India, where it is a valuable part of the diet for the significant vegetarian population and an affordable source of protein in poor communities. India currently imports lentil to meet shortfalls in local production and ensure food security, creating opportunities to expand the market for Australian lentil in India. Understanding the specific behaviours and attitudes that may predict future demand for lentil in India will benefit the pulse industry in Australia. A total of 2070 Indian adults (52.9% male, 47.1% female), completed an online survey which was matched to be representative of the Indian population with respect to region. Results suggested that consumption of lentil is high, and demand is likely to remain stable. Indians also expressed a willingness to purchase Australian lentils, and held highly positive views about Australian lentils. Specific attitudes and values held by Indian lentil consumers are discussed, along with implications for product innovation and marketing/labelling.

10B.4

UNCOVERING THE UNTOLD STORY OF GLUTEN AVOIDANCE

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There are a number of people that report following a non-prescribed gluten-free diet in order to mediate health symptoms they believe are directly associated with its consumption. These choices are often met with scepticism and can lead to major dietary change without the guidance of medical professionals. This research was aimed at developing an in-depth characterisation of this population in order to identify the factors that drive these choices and behaviours. The results indicate that non-prescribed gluten avoiders are a distinct and homogenous group, sharing similar perceptions and food choice preferences that modify their relationship with food as a whole. The perceived symptoms experienced by this population may be masking a more general sensitivity dysfunction, driven by heightened sensual experiences with all types of food. An examination of individual differences confirms that these symptoms are connected with the capacity to attend to, and cope with internal stimulation – including the sensations associated with eating. This research is amongst the first to consider the role that psychology plays in the manifestation of these symptoms, expanding our understanding of the issues that drive this select group of dieters.

ABSTRACTS: POSTERS

P1

NOVEL APPROACHES TO QUINOA SAPONIN REMOVAL ASSESSMENT TECHNIQUES IN WESTERN AUSTRALIAN TRIALS

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Bitter- tasting saponin (a compound toxic to humans) is found on the outer surface of quinoa. It requires removal to create a more palatable product and mitigate potential health complications from excessive saponin consumption. In preparation for human consumption, quinoa traditionally undergoes a process of washing and drying. For reasons of health and palatability post processing quinoa saponin level estimation is required. This is usually undertaken through the utilisation of expensive analytical chemistry instrumentation such as HPLC and LC/MS. To support the West Australian Quinoa trials and reduce the cost of saponin estimation a standard afrosimetric method was assessed for novel techniques to remove saponin levels with scarification applied after washing and drying the trial material. In addition to the existing afrosimetric technique, a further novel saponin level assessment technique was developed via the use of a surface tension water droplet method.

P2

COMPARATIVE COMPOSITIONAL ANALYSIS OF DIFFERENT VARIETIES OF WHEAT STRAW WITH SPECIAL REFERENCE TO BIOACTIVE CONSTITUENTS

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The core objective of current study was to characterize the wheat straw for its nutritional and bioactive profile. For the purpose, four different wheat straw varieties i.e. Ujala-16, Johar-16, Gold-16 and Galaxy-13 were procured from Ayub Agriculture Research Institute, Faisalabad, Pakistan. The whole research was conducted in two different phases. In 1st phase, nutritional composition and mineral profile of wheat straw were probed through their respective methods. In 2nd phase, wheat straw was characterized for its important bioactive constituents such as lignin, cellulose and hemicelluloses, phytosterol, policosanol content. The data obtained for each parameter was subjected for appropriate statistical design to determine the level of significance. Results elucidated that nutritional profile and bioactive components varied widely in different varieties. Chemical composition and mineral profile revealed that different wheat straw varieties contained 7.75-9.24%, 3.98-5.06%, 3.43-3.98% and 1.60-2.24% moisture, ash, protein and fat contents respectively, whereas, potassium, calcium, phosphorus and magnesium were 1.19-2.03ppm, 0.10-0.79 ppm, 0.10-0.98 ppm, 0.03-0.98 ppm, respectively. Moreover, lignocellulosic mass: cellulose 37.75-38.18%, lignin 15.67-16.07%, hemicelluloses 28.25-28.98% was present in wheat straw and varied significantly among different varieties. Conclusively, wheat straw is an excellent source of many important bioactive moieties especially lignocelluloses that make it more functional and more useful.

P3

CHARACTERIZATION OF PUFFED AND FREEZE-DRIED LUPIN SEEDS

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Australia is a major producer of lupin. Lupin is high in protein and fiber, gluten-free, low glycaemic index and contains many compounds with documented health benefits. These have led to great interest to use lupin as an ingredient in food. However, lupin has not been fully utilized in food due to a number of technical drawbacks in the processing of lupin. Therefore, new approaches for lupin processing is required to increase its usage in food systems. This study investigated the use of puffing and freeze drying to modify lupin seed texture. Lupin seed moisture content before puffing (MCBP) was adjusted to 10, 15, 20, 25% while moisture content before freeze drying (MCBF) was adjusted to 15, 30, 45, 63%. All puffed samples were thicker than raw sample although no significant changes in seed depth, width and density were observed. High MCBP resulted in thicker puffed samples. Freeze dried samples were significantly bigger than raw samples. High MCBF resulted in bigger freeze-dried sample with lower density. Water absorption capacity of most freeze-dried samples was higher than the raw and puffed samples. This is consistent with scanning electron microscopic study which showed less densely packed cell structure of freeze-dried samples compared to puffed samples. Freeze-dried sample with lower MCBF was found to have significantly tougher texture. Lower MCBP however, did not translate to tougher texture of puffed samples. All puffed samples were darker and more yellow compared to raw and freeze-dried samples. This study demonstrates the possibility of using food processing method to modify physical properties of lupin seeds.

P4

CREATION OF A MILLING PERFORMANCE INDEX (MPI) BASED ON THE BEHAVIOR OF WHEAT DURING LABORATORY MILLING

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For most of the laboratory technicians, test milling is just a mandatory step aiming to transform grain into flour. Their objective is to produce a flour, representative from the grain that will be therefore analyzed in order to determine its quality. In the best case, the laboratory milling process will be characterized in terms of extraction rate and eventually flour ash content.

A consortium grouping different actors of the wheat chain (Researchers, Breeders, Farmers, Millers, Bakers…) worked during 6 years to better understand how wheat behaves during the industrial milling process. The project was divided into 3 chapters, A/ understanding wheat fractionation on scientific basis, this part led to many publications, B/development of a reference Pilot mill, which was built near the French Milling School in Surgères, C/ Development of a laboratory scale mill able not only to produce flour but also to assess the wheat performance during milling.

A new laboratory mill was designed, the LabMill. Its diagram was studied to mimic as close as possible the different actions that occur during industrial milling. Although reducing the complexity of industrial mill into a "2 Breaks, 1 sizing, 3 Reductions" diagram is a real challenge, the results obtained from the mill are very promising.

The talk will present data obtained while testing 150 wheat collected across 14 countries worldwide and exhibiting very different behaviors. Product repartition within the diagram, and thus different devices charge, is greatly dependent of wheat performance during fractionation. These observation lead our research team to develop a simple way to describe this unique wheat characteristics. Our work led to the development of a 3 digit Milling Performance Index (MPi). The first Digit represents the wheat resistance to crushing at first break, the second digit represents the easiness of dissociation related to the capacity to produce fine middling instead of coarse middling, and the third digit represents the easiness of reduction of the fine middling into flour.

Data analysis clearly showed that wheats with the same extraction can have very different MPi meaning that they will behave completely differently during the process, creating variability. On the contrary, wheat with the same MPi exhibit very similar and constant product repartition throughout the diagram.

Our first results relating our results to Surgères Pilot Mill on 30 wheat show that the LabMill gives a very good prediction of industrial Break flour (r^2= 0.80), a good prediction of Sizing Flour (r^2= 0.66) and a very good prediction of Reduction flour (r^2 = 0.77).

The LabMill is introducing a new way to consider laboratory wheat milling. This new approach offers a real possibility of improving the communication between the lab and the production plant by sharing information about the wheat milling performance. Of course, the flour obtained from this test mill is, as always, representative of the wheat quality in terms of ash content (0.55% db average) and rheological properties.

P5

DIVERSITY AND EFFECT ON QUALITY OF *WX* GENE IN RICE

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Rice is one of the main food for human's life, it is the main food with largest population in the world, since development of economic society, people has improved the requirement of rice quality. An important factor for rice cooking and eating quality is amylose content, *Wx* gene in rice is a main gene for amylose synthesis, it is advantage, therefore, for human to realize the physiological and biochemical relation between *Wx* gene and rice quality, providing theoretical basis for make use of *Wx* gene and improve rice quality by research of *Wx* gene, amylose content and other rice quality. In this study, we collect 278 cultivated rice materials from all over the world, analysis the diversity of the sequence of *Wx*, rice quality and the correlation between *Wx* and rice quality. Results are as follows:

(1) We test and analysis the *Wx* gene sequence and found 66 mutation sites, *Wx* gene's nucleotide diversity is not remarkable, then we blast the sequence of *Wx* and found 6 known Wx alleles, including Wx^a, Wx^b, Wx^{in}, Wx^{op}, Wx^{mp} and *wx*. The Wx^a, Wx^b, Wx^{in} account for 95% of the total. Study by clustering analysis,we found 2 gene group, the sequence of Wx^b, Wx^{in}, Wx^{mp} and *wx* is similar and the sequence of Wx^a, Wx^{op} is similar.

(2) We test an analysis the quality of rice and found amylose content have a wide distribution, but many materials are range to 15-25%, the RVA is also have a wide distribution and variable coefficient is more than 20%. Study by correlation analysis we found it has highly significant correlation between amylose and RVA (include HPV, BDV, CPV, SBV, CSV, PeT). It is proved that the change of amylose content will effect on the RVA.

(3) We analysis combine Wx and rice quality, found that the amylose content controlled by Wx alleles is different and has obvious characteristics. The amylose content always shows $Wx^a > Wx^{in} > Wx^b > Wx^{op} > Wx^{mp} >$ wx. Then we combine the characteristic value of amylose content and RVA, found that the rice cooking and eating quality might show $Wx^{op} > Wx^b > Wx^{mp} > Wx^{in} > Wx^a$Exploring new *Wx* alleles could provide human more useful resources to improve rice quality, meeting the demand of modernization and improve human's life standards.

P6

DETERMINATION OF PHYTIC ACID CONTENT OF DIFFERENT VARIETIES OF AUSTRALIAN GRAINS

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Australia plays an important role in producing grains for domestic and worldwide consumption and hence makes a significant contribution to human nutrition. There is a growing market for healthier and functional grains around the world and for Australia to maintain a profitable and sustainable grains industry it is important to identify varieties with superior nutritive profiles. A possible approach is to search for high yielding grains with less anti-nutrients.

It has been well documented that phytic acid (*myo*-inositol 1,2,3,4,5,6-hexakisphosphate; IP6) is the most important anti-nutrient in grains. It is present naturally in the grains (0.8-1.5 mg/100g, dw in cereals and 0.4-1.8 mg/100g, dw in legumes). Phytic acid has adverse health effects if consumed as food or feed due to the ability to chelate important micronutrients including Ca, Zn, Mg, Fe and Mn as well as vitamins and proteins and therefore reduces their bio-availability in the body. Many serious health problems including anaemia, osteoporosis, lack of growth and development are related to high intake of phytic acid. Phytic acid can also affect food digestion by impairing enzymes required for food digestion, including pepsin and amylase needed for protein and sugar digestion.

Even though cereals and legumes are among the best sources of dietary fibre, proteins, minerals, vitamins and bioactive compounds, hence recommendations to consume more of them in the diet, the presence of phytic acid in cereals and legumes prevents the nutrients from being absorbed by the body. This could be amongst the reasons for the high prevalence of diseases such as anemia and osteoporosis in Australia and worldwide.

There is a growing interest in identifying low phytate grains in other major grain producing countries such as USA, Europe, Japan and China as the market of such grains is growing rapidly. In USA, low phytate grains including maize and wheat have been developed. Chinese scientists are developing low phytate rice grains. However, there is a lack of knowledge in Australia about low phytate cereals and legumes.

The main objective of this project is to introduce an alternative method to reduce phytic acid intake by identifying grain varieties which are naturally low in phytic acid content. Thus, various varieties of wheat, oat, barley, beans and lupin were tested using Megazyme Kit and compared for their phytic acid content.

Comparing the phytic acid content of different grains showed that faba beans (0.87%) and lupin (0.77%) had the higher amount of phytic acid compared to wheat (0.57%), field pea (0.56%), barley (0.50%) and oats (0.47%). Grain variety affected the phytic acid content of the samples. For example, amongst different barley varieties tested in this research, Schooner had the highest phytic acid content (0.62%) while Scope had the lowest (0.43%) phytic acid content. Similarly, Dart and QAL2000 were the tested wheat varieties with the highest (0.83%) and lowest (0.34%) phytic acid content, respectively.

P7

EFFECT OF OLEASTER POWDER AS A FUNCTIONAL INGREDIENT ON BATTER AND CAKE QUALITY

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Oleaster or Persian olive *(Elaeagnus angustifolia* L.) is a member of the *Elaeagnaceae* family with soft, sweet and dry fruits. In traditional medicine, Oleaster is widely used in treatment of a wide range of diseases including gastric disorders, diarrhea, nausea, vomiting, jaundice, asthma, flatulence and for treating pain, especially in rheumatoid arthritis. Phytochemical studies have shown that the fruit of Oleaster is rich in bioactive compounds such as flavonoids compounds, sitosterol, terpenoid, coumarins, carotenoids, vitamins with great potentials in the food and pharmaceutical industries. Despite the feasibility of producing Oleaster flour from its dried fruits, there is limited knowledge available to show its applications in various food products. The main objective of this research was to improve the nutritional quality and health benefits of cakes using Oleaster flour with various particle sizes of 125, 210 and 500 μm and levels (0, 25, 50, 75 and 100%, w/w, flour basis). The results showed that the batter consistency increased with increasing the level and reducing the particle size of the Oleaster powder. Cake volume reduced with increasing the Oleaster level however, changing the particle size of the Oleaster had no significant effect on the cake volume. Increasing the concentration and particle size of Oleaster resulted in darker crust and crumb. Sensory analysis results showed a significant reduction in the scores given to the samples containing higher concentrations of Oleaster with larger particle sizes. However, the sample containing 25% Oleaster of any particle size tested in this research showed acceptable sensory attributes close to the control sample.

P8

ASSESSMENT OF LUPIN-WHEAT NOODLES

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Lupin is a high protein, low starch, high fibre food that offers human health benefits. Use of lupin flour has been investigated in a range of applications including bakery products, breakfast cereals, and non-soy tofu. Researchers working with pasta and instant noodles have found whole lupin flour substitution rates above 10% to be deleterious to noodle quality attributes. In the current work lupin flour was substituted for wheat flour at a rate of 20% and used to produce white salted noodles. Two different lupin flours were used (*Lupinus angustifolius* from WA and *L. alba* from NSW) to investigate differential response across lupin source. Raw noodle texture was observed to decrease in firmness with lupin addition, although difference to the control reduced markedly when stored for 24 hours. Optimum cooking time decreased by up to 2 minutes compared to the control and water uptake also reduced for the lupin samples. Cooked noodle texture analysis showed a decrease in noodle firmness, particularly for the WA lupin sample. Conversely, the NSW lupin sample showed greater deviation from the control in other textural properties of springiness, resilience and chewiness.

P9

DEVELOPMENT OF SYMBIOTIC BREAD USING STRAIGHT DOUGH AND FROZEN PART BAKING METHODS

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There is a growing market for functional foods including probiotics, prebiotics and symbiotic products. Although symbiotic dairy products have been produced and marketed worldwide, non-dairy symbiotic foods are highly demanded because of the increased trends towards vegetarianism, health issues related to dairy products including lactose intolerance, milk protein allergy and blood cholesterol management. While production of probiotic or prebiotic breads has been studied extensively, there is a lack of information on development of symbiotic breads using different bread making methods. The main purpose of this research was to study the effects of two industrial bread production methods including straight dough and frozen part-baking methods with different frozen storage times (2-56 days) on the quality of symbiotic bread using inulin as a prebiotic and GanedenBC30 as a probiotic.
Symbiotic bread was produced by straight dough and frozen part-baking methods using inulin as a prebiotic (0-7.5% in straight dough method and 5% in frozen part baked bread) and GanedenBC 30 as a probiotic. With addition of inulin, water absorption and dough softening reduced, but dough development and stability time increased. Inulin prevented excessive moisture loss during storage, enhanced crust darkness and crumb firmness while reduced bread volume. Increasing the frozen storage time (up to 56 days) had no effect on bread moisture content, but it reduced volume and increased firmness and crust lightness. Samples produced by straight dough method had acceptable levels of probiotic (7.45, 6.45 and 7.43 log cfu/g, respectively) complying with the WHO recommendation. Frozen storage had no effect on the probiotic content of the samples and it increased to 7.35 log cfu/g (above the minimum recommended level) after re-baking and storage at room temperature.

P10

A METHOD TO MEASURE ALL TYPES OF FRUCTAN; INULIN, LEVAN AND AGAVE (HIGHLY BRANCHED) FRUCTAN

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Fructan is a mixture of oligomers and polymers of differing degrees of polymerization (DP) composed of fructose with a terminal D-glucosyl residue. Three major "types" of fructan occur in nature; inulin [mostly a β-2,1-linked], levan [mostly β-2,6-linked] and agave-type fructans [highly branched, with both linkage types]. Inulin and the oligosaccharides derived from hydrolysis (fructo-oligosaccharides; FOS) are widely used in the food and nutraceutical industries. Two methods have traditionally been used to measure inulin and both of these employ *exo*-inulinase and *endo*-inulinase. AOAC Method 999.03 accurately measures native inulin, and branched fructans, but significantly underestimates levan-type fructans. To resolve this limitation, we have recombinantly produced *endo*-levanase and this was incorporated into reagents used in AOAC Method 999.03 for fructan determination. The method was then used for the measurement of the fructans present in temperate pasture grass species, giving a higher fructan content for such materials. Fructan was purified from Timothy grass (*Phleum pretense*) and analysed by NMR and shown to be β-2,6-linked, as reported in literature. This polysaccharide was further studied by hydrolysis with *endo*-levanase, and characterization of the released oligosaccharides by sugar analysis, HPLC and ion chromatography. Pure Timothy grass fructan was quantitatively hydrolysed to fructose and glucose by the combined action of *endo*-levanase and *exo*-inulinase (*endo*-inulinase was not required for complete hydrolysis).

The third type of fructan (Agave fructan; highly branched) is more resistant to hydrolysis by the above enzyme mixture than are the other fructans. However under te standard incubation conditions with *exo*-inulinase and endo-inulinase hydrolysis is complete within 20 min. Lower reported values for fructan in commercial Agave fructan preparations is due to the high levels of free fructose and glucose and of sucrose in these preparations.

In this presentation, various aspects of the hydrolysis of fructans will be discussed in detail, and an improved method for the measurement of all types of fructan will be described.

P11

EFFECT OF HYDROCOLLOIDS ON RHEOLOGICAL BEHAVIOUR OF LUPIN-WHEAT DOUGHS

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Lupin is a highly nutritious legume and Australia is one of the world's largest producers and exporters. While predominantly used for stock feed, lupin offers great benefits in human diets. Flour prepared from de-hulled grains is high in protein, low in carbohydrates, a good source of fibre, and contains bio-active compounds such as polyphenols and flavonoids. Due to this attractive nutritional profile, there is growing interest in developing lupin food products, for example incorporation of lupin flour into bread. However incorporation at rates sufficient to offer real health benefits also results in reduced loaf volume and poor crumb structure, leading many researchers to optimise incorporation at levels of only 5% to 10%. There has been a lack of research into possible solutions to these deleterious effects on product quality through the use of hydrocolloids. In the present work, an incorporation rate of 20% lupin flour was used. Additions of 5% gluten, and 0.5% and 1% of xanthan, caboxymethylcellulose (CMC) or guar gum were made and the resultant effect on rheological properties of the lupin-wheat dough observed.

P12

POTENTIAL VARIATION IN THE MEASUREMENT OF WET GLUTEN

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Wet gluten content and quality in wheat determines many dough and processing characteristics and is a significant factor in the global wheat trade. Wet gluten, gluten index, indicative of gluten strength, and dry gluten, indicative of water binding capacity, are parameters measured to indicate gluten quality. Gluten quality can be affected by a range of factors, such as variation in growing and environmental conditions during grain-filling, agronomic practices, varietal differences as well as blending and storage conditions. Laboratory methods for measuring gluten parameters need to be accurate, reliable and robust, ensuring specific wheat varieties or classes have desirable processing qualities most suitable for the intended end-use. Sources of variation within the laboratory environment may arise from testing carried out by different analysts, grinding equipment for preparation of wheat meals, gluten instrumentation from different manufacturers and variation between wheat varieties ranging in protein content. The objective of this study was to assess these potential sources of variation in the measurement of gluten within the laboratory environment.

P13

EFFECT OF ENCAPSULATION ON THE VIABILITY OF PROBIOTIC BACTERIA IN CEREAL BASED BEVERAGE

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Probiotics have outstanding potential against various infective and noninfective disorders. Yogurt, cheese and fermented milk are well known in market due to their important role in probiotic delivery. However, the demand for non-dairy product is increasing due to certain issues of dairy products i.e. certain allergies, lactose intolerance and high cholesterol. Cereals products (fermented and non-fermented) as probiotic carrier substitute to dairy products have good potential for the production of functional foods. In the present study, the probiotics were encapsulated by extrusion method by using sodium alginate as biomaterial. The prepared beads were characterized by Scanning Electron microscopy (SEM). Free and encapsulated probiotic were incorporated into the cereal based fermented beverage. The product was subjected for physicochemical and microbiological analysis. The viability of the freed and encapsulated probiotic was accessed over a period of 15 days of storage. The finding showed that encapsulation has a significant effect on the viability of the probiotic bacteria in cereal based beverage. It was investigated that the encapsulated probiotic bacteria showed slow decrease from 9.67 CFU/mL to 7.69 CFU/mL than the free cells from 9.63 CFU/mL to 5.36 CFU/ml during storage period. Minor changes in the pH and acidity of the cereal based products were observed. Data from Sensory evaluation showed that fermentation improve the flavor, texture and overall acceptability of the products.

P14

SALT IN BREAD

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Sodium intake is associated with high blood pressure, which is linked to cardiovascular disease including an increased incidence of strokes. Bread is a major contributor of sodium intake in Australian diets with consumption of two slices a day accounting for up to 25% of the recommended upper limit for sodium intake. Sodium not only contributes flavour in bread but is also important for development of gluten structure and final bread characteristics. Addition of salt increases dough strength and water absorption. There is pressure from public health authorities to reduce sodium levels in bread and the major bakeries have responded by gradually lowering salt addition. Lower levels of salt reduces the tolerance of dough to machining and concerns for bread making are apparent if bakeries are required to further reduce sodium levels. Given the connection between the salt addition and dough strength, this paper questions whether this has implications for the required dough strength of Australian wheat varieties. Dough testing and baking results are evaluated over a range of salt addition levels and with flours ranging in dough strength. It is anticipated that this may have implications for Australian wheat classification guidelines.

P15

CHEMICAL MODIFICATION OF WHEAT GLUTEN BY USING POLYVINYL ALCOHOL FIBRES-GLYOXAL COMPLEX

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Chemical modifications of wheat gluten (WG) by using mixing complex polyvinyl alcohol fibre (PVAF) glyoxal were investigated. The selected amounts of (PVAF-Glyoxal) complex were 5 wt.% and 10 wt.%) as additives of wheat gluten. The solution mixing of (WG/PVAF-Glyoxal) composites was followed to prepare the samples. The wheat gluten and WG/ PVAF-Glyoxal composites were analysed under two different humidity 50 RH and 85 RH. All samples were analysed by FTIR, UV-VIS, 1HNMR, thermal properties Thermogravimetric analysis, TGA), morphology tests (SEM) and the resistance of water uptake and compared with the results of WG. The obtained results from FTIR, UV-VIS, 1 NMR showed that WG/PVAF-Glyoxal composites under the two humidity conditions have less absorbance and more crosslinked compared to control sample (WG). The results of TGA exhibited higher thermal stability after exposing the two humidity condition. The water uptake showed lower values compared to the control samples. The morphology tests (SEM) displayed that composites are more interaction, homogeneous and smooth on the surface compared to WG after exposed to humidity.

P16

HOW AMYLOSE MOLECULAR FINE STRUCTURE OF RICE STARCH AFFECTS PASTING AND GELATINIZATION PROPERTIES

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Starch molecular fine structure can have significant effects on pasting and thermal properties of rice flour. This study investigates the mechanistic explanation of these effects by obtaining data for rice flour with different starch fine structures. Starch structural parameters for both amylose and amylopectin were obtained using size-exclusion chromatography (SEC, a type of gel-permeation chromatography, GPC), and the data fitted with methodologies (two of which are new) based on the underlying biosynthetic processes. It is found that the setback viscosity of rice starch measured by the rapid viscosity analyzer (RVA) depends not only on amylose content but also on the amount of long amylose chains and the size of whole amylopectin molecules. In addition, significant determining factors for the peak and trough viscosity are the amounts of short and medium amylose chains. Conversely, long amylose chains and large amylopectin molecules are found to be responsible for the lower peak and trough viscosities. Other results for the effects of amylopectin chains are consistent with the literature. Mechanistic explanations for all observations are put forward. The novel findings about the influence of the distribution of amylose chain lengths and whole amylopectin size, in addition to amylose content alone, can provide guidance for rice breeders and food scientists in the selection of rices with improved functional properties.

P17

EFFECTS OF BARLEY GRAIN SIZES ON THE MASHING PERFORMANCE HOW BARLEY GRAIN SIZES DETERMINE THE SUGAR PROFILE DURING MASHING?

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Barley grain size is one of the crucial barley features that can directly impact the malting and mashing performance. Our previous results had shown that though barley grain sizes were positively associated with starch contents, this probably have nothing to do with the starch structure. Starch is of great importance in determining the functional properties of fermentable sugars released due to hydrolysis of malt starch during mashing. However, no research has been conducted investigating the effects of varying barley grain size on the mashing performance, nor the possible mechanism beneath it. Accordingly, the main objective of this project was to investigate: 1) the effects of barley grain sizes on the mashing performance in brewing using nine different barley samples, each of which contains different grain size fractions and 2), one particular barley variety, Commander which had been sieved into different size fractions, underwent malting and mashing experiments so as to investigate the mechanisms concerning the effects of barley grain sizes on the fermentable sugars content in brewing. Both micro-malting and mashing experiments were based on commercial methodologies while starch molecular structure information was obtained using size-exclusion chromatography (SEC). A significant positive correlation was observed between larger grain size and wort density. Meanwhile, it was found that among the same variety of barley, samples with grain size larger than 2.5 mm had the highest fermentable sugars production after mashing. This study provided information that brewing industries should consider larger grain size as a useful parameter in determining extract potential for economic purposes.

P18

EFFECT OF NITROGEN FERTILISER RATE AND TIMING ON GRAIN QUALITY PARAMETERS AND PROTEIN COMPOSITION OF RICE GROWN IN SOUTH-EASTERN AUSTRALIA

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Nitrogen fertiliser is an important crop management practice used to increase yield. Growers use the previous growing history of a paddock to determine the correct nitrogen (N) rate, as there is no appropriate soil N test for rice. In south-eastern Australia, the total N rate is often split into two applications to reduce the risk of sterility induced by cold temperatures and high N uptake. This strategy involves a basal N application applied pre-permanent water (PW) and the second application following panicle initiation (PI). While previous research demonstrates that split N application (Pre-PW and PI) affects crop yield, data investigating the impact on grain quality is relatively sparse. Using the medium-grain, semi-dwarf rice variety YRM70, we compared the effect of eight N treatments (Five N rates applied pre-PW and three split treatments with the same total N rate) on grain quality parameters and protein composition. These data revealed increasing the rate of N applied pre-PW significantly increased whole grain yield (WGY; the proportion of whole grain expressed as a percentage of harvested grain), however, splitting the same total N rate into two applications reduced WGY. WGY decreased as the rate of the first N application decreased and the second dose increased. We also observed this trend for RVA setback with the split N treatments producing a more negative setback than the pre-PW N treatments. When analysing protein composition, glutelin and globulin showed significant positive correlations with N uptake at PI while albumin was negatively correlated. Prolamin concentration increased as the N rate applied after PI increased which concurrently reduced the globulin concentration. We found that albumin and globulin were significantly negatively and positively correlated with WGY and RVA setback, respectively. Applying N after PI increases the prolamin and albumin concentrations which significantly decreases WGY and RVA setback. These results indicate altering the nutritional management of rice changes the protein composition affecting grain quality parameters.

P19

EFFECT OF GENOTYPE AND ENVIRONMENT ON ALKALOID CONTENT AND COMPOSITION AS MEASURED BY GC-MS

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In recent years there has been an increased interest in lupins as a food ingredient due to its demonstrated health benefits. Wild-type lupins often have high levels of alkaloids. In modern medicine, alkaloids such as morphine, quinine and codeine are widely used as drugs. High levels (> 200 mg/kg) of lupin alkaloids are generally unpalatable and considered unacceptably toxic to both humans and livestock, however, the lupin alkaloids have a role in reducing insect infestation when present at sufficiently high levels. Lower levels are generally recognised as safe for humans and animals. Therefore, the right balance of alkaloids is essential in commercial lupin varieties.

This poster describes a newly developed method to quantify and identify the principal alkaloids in lupin seeds. This method has been applied to a wide range of genotypes grown in two different locations in Western Australia. The total alkaloid levels ranged from 0–440 mg/kg in one location compared to 0–46 mg/kg in the second location. These results demonstrate the wide variation in alkaloid levels caused by genetic and environmental factors.

P20

FUNCTIONAL AND TEXTURAL PROPERTIES OF A DEHULLED OAT (*AVENA SATIVA* L) AND PEA (*PISUM SATIVUM*) PROTEIN ISOLATE CRACKER

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Recently, the incidence and prevalence of non-communicable diseases such as obesity, diabetes, and cardiovascular diseases have increased by different factors. Among the factors that trigger them, highlight a sedentary lifestyle and high-fat diet. Excessive consumption of high content energy and processed foods contribute to the increase of these pathologies. These change that driving to the development of functional foods designed to meet specific customer needs and a bonus for the presence of bioactive agents these can be: dietary fiber (soluble and insoluble), phenolic compounds (flavonoids and phenolic acids, etc.) and peptides. Cereals and legumes are rich in these bioactive compounds, so it has increased the interest in the consumption of on bioactive compounds and their sources, either individually or in combination. Based on these bioactive compounds sources, an alternative to functional food could be the combine cereals and legumes on a food with low caloric content could have the potential to confer health benefits.

P21

ANTI-ADIPOGENIC PROPERTIES OF CANOLA MEAL EXTRACTS

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Canola meal is a low value by-product of canola processing. Extracts from canola meal have the potential to be used as a functional food ingredients as they contain compounds such as phenolic acids which have been shown to have human health benefits. In this study, water (WE) and various 80% organic solvent/water mixtures: methanol (ME), acetone (AE), ethanol (EE), butanol (BE), chloroform (CE) and hexane (HE) were evaluated for their ability to extract compounds from canola meal that have *in vitro* anti-obesity properties. Anti-obesity properties were studied using adipogenic differentiation inhibition of a murine mesenchymal stem cell line (C3H10T1/2) and a pancreatic lipase inhibition assay. AE, ME and BE gave rise to a marked reduction ($p<0.05$) for both adipogenesis and pancreatic lipase activity. AE was shown to down-regulate the gene expression of a major adipogenic transcription factor, peroxisome proliferator-activated receptor gamma (PPARγ). Furthermore, the characterization of AE revealed high recovery of phenols such as sinapine, ferroyl choline guiacyl and other sinapic acid and kaempferol derivatives which are known to be associated with adipogenesis inhibition.