LACC IGW

4th ICC Latin American Cereals Conference

11-14 March 2018

Hilton Reforma Hotel
Mexico City, Mexico

Book of Abstracts

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Welcome to the 4th Latin American Cereals Conference in Mexico, 2018!

Dear colleagues and friends,

It's a great pleasure to welcome you to Mexico on behalf of the International Association for Cereal Science and Technology (ICC) and the International Maize and Wheat Improvement Center (CIMMYT).

For the first time, ICC and CIMMYT are collaborating for the LACC4 - 4th ICC Latin American Cereals Conference in combination with the IGW - 13th International Gluten Workshop so that cereal science and technology in Latin America will be in the spotlight.

LACC is an event series of international conferences that promotes scientific and technological knowledge related to the production of grains, cereals and food. The multidisciplinary audience is characteristic for LACC. We welcome professionals connected to the value chains of grains and cereals from agricultural production to the food industry and consumers.

At LACC4 experts from around the world will present on themes spanning from recent developments in breeding and agronomy to cereal processing technologies, quality assessment, and nutrition and health and food safety and security.

As participants you will find a program of the highest scientific quality with keynote lectures, presentations, and poster sessions on recent developments selected from large numbers of submitted abstracts, while industry will showcase its products and services.

We would like to thank all the global experts who will share their research and insights as well as the endorsing organisations that advertised the LACC4 all over the world. Our special thanks also go to our sponsors and exhibitors who will contribute significantly to the success of this conference.

Today, many branches of science require even greater international collaboration than before, and ICC actively pursues the development of links with cereal and food associations at country, regional and international level. Enabling a unique platform for collaboration on a global level where participants from around the world can interact and exchange knowledge and experience is a main goal of ICC.

We look forward to interacting with you during the LACC4 and wish you a fruitful conference and enjoyable stay in Mexico City!

Yours sincerely,

Hamit Köksel
Chair of LACC4 and ICC President
Hacettepe, Turkey

Carlos Guzmán
Chair of IGW,
CIMMYT, Mexico

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KEYNOTE LECTURES

GLOBAL FOOD SECURITY AND THE ROLE OF CIMMYT

Martin KROPFF, Director General, International Maize and Wheat Improvement Center (CIMMYT)
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Cereals such as maize, rice and wheat are the bedrock of global food security, today and in the future. To feed a global population of 10 billion by 2050, it is estimated that global crop production must double. However, future production increases must be achieved while bringing very little new land into cultivation, and with greater pressure on resources such as soil, water, fuel and nutrients. Recent years have also shown that current food supply systems leave the poor highly vulnerable to market price volatility; with the majority of future population growth set to occur in less developed nations, we need to ensure that agri-food systems do a better job of making food accessible and affordable. Finally, health and nutrition are issues of increasing priority. While the number of undernourished around the world has fallen to 800 million – still a large proportion of the global population – as many as two billion people suffer from micronutrient deficiency, while 650 million of the adult population of the world is now obese.

The considerations outlined above make it clear that, while we do need increased investments in cereals research to achieve necessary productivity gains in the face of challenges such as climate change, we also need integrated research strategies and partnerships to achieve these gains sustainably and within a more effective global food supply system. At the level of research, this includes developing varieties with a focus on the end user, enabling more nutritious cereal-based foods that meet consumer preferences and needs within the context of their broader diet. At the level of partnerships, it means working with policymakers, seed and agricultural service companies of all sizes, alongside a focus on the agri-food sector.

Keywords:
Global food security, demand, markets, population growth, health, nutrition, climate change, cereals, policy

THE POWER OF PULSES: CAPTURING NEW OPPORTUNITIES FOR PULSE PROTEINS THROUGH INNOVATIONS ALONG THE VALUE CHAIN

James HOUSE, University of Manitoba, Winnipeg, Canada
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In 2016, global pulse production was 82 million tonnes from 82 million ha (FAOSTAT, 2018). Advancements in pulse breeding and agronomy have led to increased hectares under pulse production, as well as improvements in pulse yields. In 2013 (latest date available), global pulse consumption by humans was 50.5 million tonnes (62% of global production), with India contributing to 36% of global consumption. In North America, pulse consumption varies by region. In Canada, in 2013, pulse production was 6.6 million tonnes, with humans consuming approximately 0.43 MT or 7% of total production. The latter data highlight Canada's role as a major pulse exporting nation. Innovations along the pulse value chain, as well as recent consumer trends, are creating new opportunities to increase pulse consumption. Consumers are demanding food products that 1) feature plant-based proteins and 2) address societal concerns related to sustainable production practices. Pulses are uniquely positioned to address both criteria. As legumes, pulses fix nitrogen and play important roles in sustainable cropping practices. With an average protein content of 22-24% (by weight), pulses have 2-3 times the protein content of most cereal crops. However, pulse proteins present limitations in the content of key amino acids as well as certain anti-nutritive factors, which can have a depressive impact on protein quality. Capturing the full potential of pulse proteins will require new knowledge as to factors influencing their protein and amino acid composition and digestibility, including advances in genetics and agronomic practices, as well as the development of optimal blends. Innovations in protein isolation and thermal processing, including efforts to enhance the sensory attributes of pulse protein-based food products, will play critical roles in enhancing pulse protein acceptability and consumption. These efforts will lead to the realization of new opportunities to position pulse-based proteins to consumers.

Keywords:
pulses, plant-based protein, sustainability, protein processing

RESTRUCTURING AND FUNCTIONALIZATION OF CEREAL FOOD MATERIALS FOR FOOD AND NON-FOOD APPLICATIONS USING CEREAL PROCESSING AND NANOTECHNOLOGY

Jozef L. Kokini, Scholle Endowed Chair in Food Processing, Department of Food Science, Purdue University, West Lafayette, Indiana
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This talk will focus on an overview of cereal structuring technologies, including extrusion, microwave, mixing, dough sheeting and nanotechnology. The talk will give examples related to the effect of mechanical and thermal energy on starch and protein transformations including conversion of starch and fragmentation and their effect of the rheology of starch; the phase behavior of different components of cereal materials, including the glassy state, the glass to rubber transition and the impact of high temperatures during processing on crosslinking and the shift in the state diagram caused by crosslinking; expansion phenomena, the impact of phase behavior of different carbohydrate and protein components in the formation of fully expanded products and half products including glassy pellets; nucleation in various states, expansion of nuclei into full cells and biaxial extensional phenomena controlling expansion behavior; the mobility and behavior of starch and protein fractions including gliadin, glutenin during mixing using fluorescence quantum dots and their impact on expansion and eating quality during baking; nanoparticulation including desolvation coacervation and layer-by-layer deposition and the effect of chemistry, pH and salt concentration on the formation of these nanoparticles an the effect of manufacturing on the ability to encapsulate; the use of zein films to engineer biodegradable sensors for food toxins and allergens including acrylamide; the peanut allergen Ara-h1 which causes the allergenicity of peanuts, gliadins which cause allergenicity for coeliac patients etc. The talk will be broad in nature and will give examples in each area without going into methodological depth so as to cover a diverse number of phenomena of interest to cereal scientist and technologist.

Keywords:
Cereal food materials, non-food application, nanotechnology

ORAL PRESENTATIONS

Session I – Food security: Dedicated to Norman Borlaug

WHEAT – A CORNERSTONE FOR GLOBAL FOOD SECURITY

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Wheat is a key food staple that provides around 20% of protein and calories consumed worldwide and is an important source for fiber, micro-nutrients, folic acid and anti-oxidants. Demand for wheat is projected to continue to grow over the coming mainly in the developing world to feed an increasing population. Major importers remain North and Sub-Saharan Africa and East Asia other than China. The fastest demand growth is observed for Sub-Saharan Africa. Wheat will continue to account for a substantial share of human energy needs in 2050, irrespective of discussions around gluten sensitivities. Based on recent trends, an increasing number of poor consumers in low- and middle-income countries prefer to eat wheat-based food at an affordable price as populations and economies grow, women and men seek employment in cities, and dietary habits change.

Projections regarding wheat demand growth to 2050 abound and vary widely around an average of approximately +50% relative to 2010. The unfolding scenario implies a wheat demand growth of 1.4% p.a. to 2030 at constant prices. World wheat area has not increased over the last 20 years and there are limited prospects for it to increase. The main production increases will occur in the Caspian Sea region. Achieving the yield growth target of 1.4% p.a. would protect (net) wheat consumers (urban and rural) from increasing staple food prices, whereas wheat producers, including smallholders, would benefit from increased productivity and the associated producer surplus.

More than half of global wheat production comes from 75 developing countries, characterized by smallholdings and more than 90% of globally irrigated wheat is grown in developing countries. Over the period 1993 to 2015 world wheat yield grew at 1.0% p.a., considerably below the 1.4% p.a. target above. In addition, the future brings new yield constraints only now beginning to be seen in yield statistics, in particular limitations on irrigation water and climate change. The water constraint arises because of over-pumping of ground water in many regions of the world. The climate change threat is most clear in terms of projected warming (rates vary between 0.1 and 0.4 degrees C per decade, with wheat yield reduced by around -5% to -8% per degree C). Uncertainty surrounds projected rainfall change, but many models suggest Mediterranean climates may face increased drought. The conclusion from these demand and supply considerations is that developing countries and indeed the world must lift wheat yield growth rate by about 40% over the current rate, whilst increasing stresses will be exerting increasing downward pressure. Furthermore, stakeholders expect this to be achieved

sustainably, with greater input use efficiency and minimal off site environmental impact, while preserving or improving the productive capacity of the land under wheat.

The 2008 food-price crisis has highlighted the extreme vulnerability of global wheat agri-food systems. Effects of local production problems, like droughts, flooding or disease outbreaks, are amplified by global markets, causing price spikes and food insecurity for disadvantaged consumers. Lloyd's insurance company estimated that in a multiple climate and crop production shock, prices for wheat would increase 4-fold. On top of this already challenging setting, biotic stresses continue to evolve in virulence – with the earlier outbreak of Ug99 stem rust causing major upheaval. Now, for the first time, Bangladesh reported wheat blast (*Magnaporthe grisea*) in early 2016, which has thus moved outside Latin America. The bulk of global wheat consumption is met by national and regional production, with about 20% or 160 M tons traded on world markets; predicted to grow by 2050, as imbalances become more frequent and acute (Abis, 2015). Improving access to markets through more effective value chains will become even more important, as global and regional trade will grow to compensate for greater production and productivity variability. The presentation will discuss the major intervention points wheat producers have to achieve the needed gains of 1.4% in areas of raising yield potential, enhancing heat and drought tolerance, biotic stresses, industrial processing and nutrition.

Keywords:
wheat, food securit, yield, heat and drought tolerance, biotic stress

MAIZE-BASED FOOD AND NUTRITIONAL SECURITY IN THE DEVELOPING WORLD

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Maize is a major food crop for hundreds of millions of consumers in sub-Saharan Africa (SSA) and Latin America. However, maize endosperm protein is deficient in two essential amino acids, lysine and tryptophan; moreover. the amounts of some essential nutrients present in maize kernels are inadequate for consumers who rely on maize as a major food source. White maize that is mostly consumed as food, especially in SSA and Latin America, lacks provitamin A (PVA) and has very low levels of kernel zinc (Zn). Both Vitamin A deficiency and Zn deficiency are highly prevalent in several countries in SSA and Latin America, leading to many health problems.

Biofortification is one of the important pillars in the global strategy to tackle malnutrition. The power of this strategy has been amply demonstrated in maize firstly through development and deployment of "quality protein maize" (QPM). Pioneering multidisciplinary efforts at CIMMYT led to development of improved QPM varieties which are now grown on more than 1.5 million hectares worldwide. With regard to provitamin A (PVA) enrichment, under the HarvestPlus program, CIMMYT has undertaken intensive breeding for PVA-enriched maize over the last 12 years. This led to: a) development of an array of PVA trait donors, inbred⁄doubled haploid (DH) lines, and improved hybrids adapted to SSA, Asia and Latin America; b) validated molecular markers and marker-assisted protocol that can bring in 10-fold improvement in PVA levels; and c) optimized phenotyping⁄screening tools for PVA, and breeding methods. In 2013, a first wave of 3 CIMMYT-derived PVA-enriched improved maize varieties (6-8 ppm) were released in Zambia. During 2015-2016, a second wave of 8 CIMMYT-derived PVA-enriched maize varieties (8-14 ppm) were released in southern Africa. In 2016, an estimated 100,000 households in Zambia were producing and consuming PVA-enriched maize. The demand for PVA maize varieties has risen steadily, especially in the HarvestPlus-targeted countries in southern Africa. In 2017, for the first time the Indian Council of Agricultural Research (ICAR) released a PVA-enriched maize hybrid, Pusa Vivek QPM9, using marker-assisted selection. Breeding for high-Zn maize at CIMMYT is relatively new, but our team has clearly demonstrated that it is possible to integrate high-Zn trait (with more than 30 ppm) into maize breeding programs and derive improved high-Zin maize varieties. Most of the high-Zn germplasm at CIMMYT is presently in QPM background, which is a "natural value-addition".

Intensive development and widespread uptake of biofortified maize varieties in the developing world warrants: a) significant investment in breeding efforts; b) strengthening local⁄regional capacities in quality analysis; c) strong nutrition awareness campaigns; d) enabling policies; and d) stimulation of downstream demand for nutritious maize products.

Keywords:
Maize, Biofortification, QPM, Provitamin A, Kernel Zinc

HARVESTPLUS ALLIANCE: RESEARCH, DEVELOPMENT AND DELIVERY OF MICRONUTRIENT DENSE CROPS

Wolfgang PFEIFFER[1], Meike ANDERSSON[2], Parminder VIRK[3],

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Plant breeding for micronutrient density (biofortification) gained legitimacy when micronutrient deficiencies were recognized as global public health challenge of the 21st century. In response, HarvestPlus - an interdisciplinary, global alliance of scientific institutions and implementing agencies in developing and developed countries - was established to add food nutritional quality to agricultural production research paradigms and reduce micronutrient malnutrition among poor at-risk populations by capitalizing on agricultural research as tool for public health interventions. HarvestPlus seeks to develop and disseminate more nutritious varieties of food staples high in iron, zinc, or provitamin A. The portfolio includes cereals rice, wheat, maize, pearl millet, sorghum; root⁄tuber crops cassava, sweetpotato, Irish potato, legumes beans, lentils, cowpea, and banana⁄plantain. When consumed regularly, these varieties can provide between 25% and 100% of a child's daily requirement for vitamin A, iron, or zinc, the three micronutrients identified by the World Health Organization as most lacking in diets globally. Biofortified crops offer a cost-effective, sustainable and rural-based intervention that, by design, initially reaches these more remote populations, which comprise a majority of the undernourished in many countries. It then penetrates to urban populations as production surpluses are marketed. Thus, biofortification complements other nutrition interventions such as fortification and supplementation. HarvestPlus' applied and strategic research is driven by an impact⁄product pathway that integrates crop development, nutrition, seed production, capacity building, marketing, advocacy and monitoring⁄impact research in country specific crop delivery plans which span the entire value chain. For biofortification to be successful, novel product concepts must consider factors associated with probability of success in achieving: i) technological goals with trait discovery and expression in adapted genotypes, ii) crop improvement goals to generate a biofortified germplasm product without compromising agronomic performance, nutrition, or end-use quality; and iii) commercial goals to guide the design and delivery of the technology. Conventional breeding developed competitive, profitable micronutrient dense crops, and by 2017, > 180 varieties are released in > 30 countries in Asia, Africa and Latin America, and leads are in-testing in > 60 countries. By the end of 2017, these varieties were grown by > 7 million farmers providing access to biofortified food to more over 35 million beneficiaries. This talk portrays the product development and commercialization agenda of the HarvestPlus alliance linking the 'state of art' of biofortification with future impact oriented strategies.

Keywords:
biofortification, hidden hunger, micronutrients, plant breeding

MASAGRO'S PARTICIPATIVE RESEARCH NETWORK ACROSS MEXICO: ADAPTING CONSERVATION AGRICULTURE TO LOCAL CONDITIONS

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Conservation agriculture (CA) is based on minimal tillage, residue retention and crop diversification and has been successfully implemented in several countries. Implementation of CA can, depending on the local conditions, improve soil quality and water-holding capacity, reduce erosion and production costs, and increase yields. In Mexican agriculture, soil degradation, low yields and high costs are common, so a switch from conventional to conservation agriculture could benefit Mexican farmers. Although based on three principles, CA is not a fixed recipe that can be readily implemented in any agricultural system. In every agro-ecological zone and production system, research is needed to identify CA-based practices adapted to the local conditions. In a country like Mexico with large diversity in production systems and conditions, this calls for a large number of trials. In the frame of the MasAgro project, CIMMYT set up a network of field trials with local collaborators, known as research platforms, across Mexico. The network was initiated in 2011 and includes existing long-term experiments as well as new research platforms started from 2011 to 2017. In 2017, the network comprised 53 research platforms. The first results on long-term effects of CA on soil health and crop yield are becoming available now across the country. The research platforms demonstrate that CA can be implemented successfully in most agro-ecological zones of Mexico and that the benefits include improved soil quality, cost reductions in soil preparation and higher yields in most rain-fed low-productivity zones. Some of the results discussed in this presentation include improved soil quality in a maize-oats rotation on permanent beds in San Luis Potosi, higher maize yields with reduced tillage and residue retention in Oaxaca, doubling maize yield by implementing conservation agriculture in Puebla, higher profits in maize production in Morelos and a yield benefit in wheat and maize in Sonora.

Keywords:
Conservation agriculture, particpative research, long term trial, Maize

MILLING QUALITY: THE ACHILLES HEEL OF CEREAL FORESIGHT STUDIES?

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After the food crises of 2007 and 2016 the global price of wheat has declined substantially, hitting a low in early 2016, due mainly to expanded wheat production world wide. In 2016 unfavorable weather conditions damaged quality in two major production regions, leading to larger than usual amounts of production ending up in feed-stock. The price of wheat increased substantially in the first half of 2017 to decrease again when 2017 proved to be a good year for what is commonly referred to as milling quality wheat. However, the prices plateaued at a higher level than before the small 2017 price spike.

One of the expected consequences of climate change is the occurrence of more erratic rainfall patterns. This implies that there will always be production areas that will be confronted with weather conditions that are not conducive to high levels of wheat grain quality (milling quality, processing and end-use quality). Unfortunately, those conditions cannot be predicted accurately in advance. Moreover, elevated CO2 levels are predicted to influence wheat quality (*e.g.* Fernando et al., 2012) and wheat quality is also influenced by heat stress, all aspects of climate change.

The question is if this fluctuating grain quality matters in the long run for food security and, related to that, if fluctuating wheat grain quality could spark a food crisis like those of 2007⁄2008 and 2011⁄2012. Globally grain quality is especially important for high-income countries in relation to bread consumption. In some of the low and middle-income countries that have wheat-based diets, milling quality currently plays a limited role due to different processing techniques, both in value chains as well as in homesteads. However, continued urbanization in combination with steady increases in disposable income are ushering in dietary change. In many low and middle-income countries, where the vast majority of the global population resides, urban consumers are shifting to wheat, where they previously depended on other staples (Mottaleb, Rahut, Ali, Kruseman, & Erenstein, 2016; Mottaleb, Rahut, Kruseman, & Erenstein, 2017). Within countries that have a wheat-based diet already, there are shifts visible towards more bread consumption. This implies that there is both a rising demand for wheat and within the demand for wheat increased demand for wheat grain quality.

In our paper, we combine several tools and methodologies in a novel way to answer that question. We apply a global integrated assessment model IMPACT (Rosegrant et al., 2017; Rosegrant & IMPACT Development Team, 2012) to get general indication of long term average supply and demand shifts based on standard scenarios related to Shared Socio-Economic Pathways (SSPs) (Riahi et al., 2017) and climate change. We apply GIS techniques with crop masks and both historical as well as plausible and probable future weather patterns to map the risk of lower grain quality. We combine this with expected shifts in demand for grain quality

wheat in overall demand to show the hotspots where gaps between supply and demand are likely to emerge occasionally, which could spark a new food crisis. Foresight studies only using integrated assessment models such as IMPACT currently cannot capture these important insights, hence the need for this novel approach to inform the research community, the wheat sector and policy makers.

Keywords:
wheat quality, climate change, foresight, food crisis

Parallel Session 2.1 – Biofortification

AGRONOMIC BIOFORTIFICATION OF CEREALS WITH MICRONUTRIENTS

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Despite increasing amount of food being available to most people globally, micronutrient deficiencies ("hidden hunger") still represent a major health problem in human populations. Iron, zinc, selenium and iodine deficiencies are well-documented micronutrient deficiencies affecting around 2 billion people and causing serious health complications and chronic diseases. Low amounts of micronutrients in soils and their inadequate dietary intake are well-documented reasons for hidden hunger. Iodine deficiency is a particular one because it is also highly prevalent in well-developed countries. Despite implementation of several intervention programs against iodine deficiency, such as use of iodized salt, inadequate iodine intake is still a growing health concern today.

High prevalence of hidden hunger is most commonly associated with increasing consumption of cereal-based foods with low amount of micronutrients. For example, the most common concentrations of grain iodine and zinc in maize, rice and wheat range from 10 to 20 µg for iodine and from 15 to 30 mg for zinc per kg grain, which are far too low to meet daily iodine and zinc requirement of human populations. Human body requires daily 150 µg iodine and 15 mg zinc.

This presentation will focus on agricultural strategies aiming at improving grain concentrations of micronutrients, by paying particular attention to agronomic strategies (i.e., targeted fertilizer application). A targeted fertilizer-strategy involves foliar application of a cocktail solution of micronutrients at particular growth stages and provides rapid and effective solution to the problem. Recent results show that combination of the plant breeding tool with a "targeted mineral fertilization practice" create additive and synergistic impacts on accumulation of micronutrients in cereal grains at desirable amounts for human nutrition.

Keywords:
biofortification, hidden hunger, micronutrients, wheat

BIOFORTIFIED MAIZE: PROGRESS AND PERSPECTIVES

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Maize is a leading staple food crop providing at least 30 percent of the total calories of more than 4.5 billion people in developing countries where the prevalence of iron, zinc and vitamin A deficiencies are high (Nuss and Tanumihardjo, 2010). Maize is a staple in Africa, where intakes ranges from 52 to 328 g⁄person⁄day and in Latin America, where consumption varies from 50 to 267 g⁄person⁄day and Mexicans consume the most maize (Ranum et al., 2014). Maize is also an important source of nutraceuticals known to enhance health and prevent diseases, such as phenolics, carotenoids (yellow maize); anthocyanins (blue maize); phlobaphenes (red maize), and insoluble and soluble dietary fiber and polar and non-polar lipids (fig. 6.1) (Hernandez-Quintero, et al., 2017; Vazquez-Carrillo et al., 2016; Serna-Saldivar et al., 2015; Zilic et al., 2012; Paredes, et al, 2009).

Because of its widespread use in different foods (especially in Latin America and sub-Saharan Africa), its diversity in nutrient content, broad adaptation to diverse production environments, and potential to generate and continually provide productive cultivars that are attractive to farmers and consumers, maize is an ideal vehicle for nutritional enhancement and delivery.

The main objective of the proVA-biofortified maize breeding program is to develop varieties that are high-yielding and profitable, with demonstrable effectiveness in reducing vitamin A or zinc deficiency, and are acceptable to the consumers (Bouis and Welch, 2010). Provitamin A enhanced maize is already available to consumers in different countries in Africa, while Zn enhanced maize will be soon delivered to farmers in Latin America. Findings, lessons and perspectives of nutritionally enhanced maize will be presented during this talk.

Keywords:

Biofortification, zinc, provitamin A, maize

BIOFORTIFICATION IN BRAZIL: IRON AND ZINC CONCENTRATION IN GRAINS ON WHEAT CULTIVARS GROWN IN DIFFERENT ENVIRONMENTS

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Biofortification of plant products has increased in importance around the world. Diets enriched with the consumption of wheat products are encouraged by food technologists. It is known that zinc deficiency causes growth retardation and immune dysfunctions, besides iron deficiency limits cells oxygenation, causing fatigue and reduced body defenses. It is estimated that 30% of the world population suffers iron deficiency anemia and that 80% is deficient in iron. In Brazil, through the Brazilian "BioFORT" program and the international "HarvestPlus" program, Embrapa began the selection of several biofortificated products, including wheat. The nutritional value of wheat products can be increased by the selection of genotypes with higher concentration of these nutrients. Iron and zinc are found mainly in the aleurone layer of the grains. Little is still known about the influence of the genetic and the environmental factors on the concentrations of iron and zinc found in the wheat cultivars and lineages currently in use in the country. The general objective of this research was to identify wheat cultivars with higher iron and zinc concentration and to use these genotypes in the Embrapa wheat breeding program, aiming to associate these characteristics also with stress tolerances and with good bread wheat cultivars. As initial results from four environments, the average values of the evaluated cultivars ranged from 19.30 to 44.01 ppm for iron, and from 20.50 to 36.83 ppm for zinc.

Keywords:
Bread wheat, Wheat quality, Biofortification, Wheat breeding

QUALITY AND CONTROL ANALYSIS OF WHEAT FRACTIONS BY USING LASER INDUCED BREAKDOWN SPECTROSCOPY

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Wheat should have the desired quality parameters according to the type of last product. These parameters can be grouped as physical, chemical and technological properties. The main parameters determining the price and quality of wheat are protein, moisture, ash, sedimentation and gluten. In the industry, traditional methods are still applied. They require long analysis time, chemicals and specialist person. However, industry needs rapid systems to determine these parameters. In this study laser induced breakdown spectroscopy (LIBS) was used to determine the quality parameters of wheat as a rapid tool.

Recently developed LIBS method is an atomic emission spectroscopy technique which employs a high energy laser to create a plasma on the surface of the sample. This high energy laser source causes a significant increment in temperature which excites atoms and the emitted light is collected by a fiber optic cable and transferred to the spectrometer. Obtained spectral signals gives qualitative and quantitative information about the elemental composition of the analyzed sample. In the study, protein, ash, elemental concentrations of wheat samples, Na analysis in breads⁄bakery products were achieved by LIBS in seconds. In order to obtain real quality parameters of samples, Dumas method was performed for protein analysis; burning at muffle furnace was applied for ash analysis and atomic absorption spectroscopy (AAS) was used for Ca and Na elemental concentrations. Recorded LIBS spectra were correlated with protein, ash, Na⁄NaCl and Ca elements' contents with the aid of partial least square method (PLS). Calibration,validation graphs and statistical values indicated that the results are very promising for wheat analysis. LIBS can be a versatile tool to be used as rapid and reliable method for quantitative determination of protein, ash, salt, Ca and Na content in cereals.

Keywords:
LIBS, Ash, protein, Ca

ADAPTATION PATTERN OF EXOTIC PROVITAMIN A BIOFORTIFIED MAIZE HYBRIDS IN PAKISTAN

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Vitamin A deficiency (VAD) is serious at the sub-clinical level in Pakistan and may progress to clinical levels, if unaddressed. Different interventions are available to combat the provitamin A deficiency but bioforitification is the most acceptable, convenient and long lasting approach. To combat VAD in Pakistan, 36 provitamin A biofortified maize hybrids were introduced from CIMMYT-Mexico. These hybrids were evaluated for agronomic and yield related traits across diverse locations viz, (I) National Agricultural Research Centre (NARC), Islamabad, (II) Maize & Millets Research Institute (MMRI), Yousafwala, (III) Cereal Crops Research Institute (CCRI), Nowshera, (IV) University of Agriculture, Faisalabad, (V) University of Agriculture, Peshawar, (VI) Jullundhur Private Limited (JPL), Arifwala, (VII) ICI-Pakistan, ICI-Sahiwal, (VIII) Sohni Dharti International (SDI), SDI-Sahiwal and (IX) Ali Akbar Group Pakistan, Bhwana. Data analysis from multilocation trial, showed the significant differences among hybrids, locations and hybrid × location interactions (HLI). Box-whisker plot for grain yield showed that Yousafwala (8.36 t⁄h) was the highest yielding site, followed by Nowshera (4.75 t⁄h) and Bhwana (4.56 t⁄h). Genotypic and phenotypic correlation of grain yield with other agronomic and yield components showed the varying magnitude and direction of correlations across the locations. GGE biplot multivariate analysis was used due to prevalence of crossover interactions across the locations. GGE biplot depicted that Peshawar, Nowshera, Faisalabad and ICI-Sahiwal were most representative and discriminating locations for these hybrids. GGE biplot for grain yield showed that 19 (HP1100-21), 2 (HP1097-2), 9 (HP1097-10), 16 (HP1100-6), 1 (HP1097-1), 6 (HP1097-6) and 4 (HP1097-4) were high yielding and theoretically ideal hybrids for subjected locations. These hybrids can be recommended for commercial cultivation to augment targeted nutritional interventions to vulnerable communities in Pakistan.

Keywords:
Biofortification, malnutrition, Provitamin A maize, multi-location trials, GGE biplot, Pakistan.

Parallel Session 2.2 –Enzymes

INTRODUCTION TO BAKING ENZYMES

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Enzymes are active proteins that are present in living organisms. They accelerate specific reactions and work under specific conditions. Enzymes are used as processing aids in small amounts and their activity depends on factors such as pH, temperature, contact time, dosage, substrate, inhibitors, etc. Enzymes are commonly used in flour and dough to improve the quality of finished baked goods by altering the way flour behaves in mixing and dough behaves in forming, proofing and baking.

Typical effects that can be achieved with baking enzymes include extended fresh-keeping, improved dough fermentation, improved dough handling and machinability, enhanced mixing tolerance and fermentation stability, increased loaf volume, improved crumb whiteness and crumb structure, more intense crust color, thus allowing clean label formulations.

Refined wheat flour, i.e. from the endosperm, contains 12-15% moisture, 65-70% starch, 7-16% proteins, including storage (gluten) proteins and water-soluble proteins, 1-3% non-starch polysaccharides, 1-2% lipids and 0.5-1.0% ash, or inorganic compounds. These flour components may be considered as substrates for modification by baking enzymes as shown in order to correct baking performance of flour, optimize the technological process parameters, attain needed dough properties, improve the quality of baked products, produce special flours, and get better cost effectiveness.

Amylases and endo-xylanases are the most widely used bread making enzymes today. Proteolytic enzymes are applied in some types of biscuits, wafers, and other baked products. The functionality of lipases and glucose oxidase offers several benefits and they have a great potential in bread-making applications.

Amylases maximize the fermentation process to obtain an even crumb structure and a high loaf volume. Maltogenic alpha-amylases improves shelf-life of bread and cakes. Glucose oxidases oxidizes glucose to produce hydrogen peroxide to strengthen the gluten network. Lipases modify the natural lipids in flour to strengthen the dough. Xylanases condition the dough for easy dough handling and improved crumb structure. Proteases weakens the gluten to give plastic properties required in doughs for biscuits.

Overall, this presentation will give information on basic enzyme chemistry, how enzymes are produced and utilized in variety of baking applications.

Keywords:
enzymes, baking, fresh-keeping

SPONGE & DOUGH BAKING WITH AUSTRALIAN WHEAT

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Enzymes are specialised proteins which act as biological catalysts, they greatly accelerate rates of biochemical reactions in plant and animal systems. In the baking industry, they have become a major component of bread improvers. The reactions of enzymes are very specific and can be linked to the principle of a 'lock and key' with the substrate being the lock and the enzyme being the key.

In this study the role of selected enzymes was investigated on selected Australian varieties. The samples ranged in flour protein content from 9.9 to 12.7% (at 13.5% mb). Sponge & Dough (S & D) baking process was used, reflecting on current practices in South East Asia (SEA). The impact of selected enzymes on bread dough rheology and final bread quality was assessed compared to the control sample containing only bread improver (ascorbic acid (AA)) and fungal alpha amylase (FAA)). Preliminary experiments had established the 'boosting' improver formulation to be used with Australian flour samples as comprising (based on flour weight):24 ppm fungal *alpha*-amylase (source Fungamyl); 25 ppm xylanase (source Pentopan) and 60 pp glucose oxidase (source Veron 191S).

The Perten doughLab and the Warburton's stickiness test (WST) have been used to examine dough rheology effects during mixing and in post mixing processing respectively. Areas of study included the impact of effect of flour type and interactions with selected enzymes. Bread volume and crumb structure were of greatest interest and studied using the bread volume analyser (BVM) and C-Cell respectively.

Keywords:
wheat quality, sponge & dough baking, dough rehology, enzymes

HAGBERG FALLING NUMBER MEASUREMENT: NEW MACHINE VERSUS CONVENTIONAL MACHINE

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Pre-harvest sprouting or germination on the mother plant and late-maturity alpha-amylase 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 detecting sprouted grains. 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 spout damage. 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. The objective of this study is to evaluate accuracy performances of this new machine. 30 whole-wheat samples and 30 white wheat flour samples covering a wide range of falling numbers (from 70 s to 450 s) are analyzed both with the new Amylab FN machine and with the Perten FN machine. The observed correlation coefficients (r^2) between the two machines are equal to 0.96 for whole meal and 0.97 for white wheat flour. 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 condition

Keywords:
hagberg falling number amylab chopin wheat flour wholemeal

OCCURENCE OF AMYLASE-TRYPSIN-INHIBITORS IN AUSTRIAN WHEATS AND THEIR TRYPSIN INHIBITION

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Besides gluten proteins, also water or salt soluble proteins of wheat, can cause a broad range of intestinal disorders. Recently Amylase-Trypsin-Inhibitors (ATIs) were identified as a major trigger of non-celiac wheat sensitivity (NCWS), which got raising awareness the last years (JUNKER Y. et al. 2012). KUCEK et al. (2015) stated that the yet published data have not evaluated the differences in ATI activity and allergenicity between modern and heritage wheat varieties. To understand how modern wheat breeding has contributed to the increase of wheat-related disorders, a broader array of modern and heritage wheat genotypes must be screened.

About 25 different wheat species (*mainly soft bread wheat, durum*, monococum, dicoccum and spelt wheat) and varieties (modern and old varieties from the 19th century) were cultivated on test fields of BOKU in Tulln, Austria and harvested in 2015. These samples were analysed in respect to their protein composition, especially the non-gluten proteins. Albumins and globulins were axtracted according to Osbourne and quantified by the Bradford assay. ATIs were measured based on a RP-HPLC method, which was verified by MALDI-TOF mass spectrometry due to their accurate mass. Additionally some samples were analyzed for their trypsin-inhibition in order to confirm gained results.

No correlation between species or age of the wheat varieties and their ATI content was found. Since the number of screened samples was quite low and only samples from one year were characterized, further analyses are necessary.

JUNKER Y. et al. (2012): Wheat amylase trypsin inhibitors drive intestinal inflammation via activation of toll-like receptor 4. The Journal of Experimental Medicine, Vol. 209, No. 13, pp. 2395–2408.

KUCEK L. J. et al. (2015): A Grounded Guide to Gluten: How Modern Genotypes and Processing Impact Wheat Sensitivity. Comprehensive Reviews in Food Science and Food Safety, Vol. 14, pp. 285–302

Keywords:
Amylase-Trypsin-Inhibitor, non-celiac wheat sensitivity (NCWS), MALDI-TOF, non-gluten proteins

STANDARDIZATION OF LOW PROTEIN WHEAT FLOURS

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The proteins of wheat are often considered as the most valuable component of the grain. In particular, the water-insoluble proteins together with pentosans and lipids form the gluten network, which is largely responsible for the technological properties of the wheat dough and the nature of the final products.

The quality and quantity of the protein are therefore an important criterion in determining the price of a wheat batch. However, like other components of the grain, the proteins not only undergo variations from one variety of wheat to another, but also vary with climatic conditions during growth and fertilization. In dry years, the protein content is usually higher and lower in humid, approximately inversely proportional to the crop yield. The probable increase in the variability of the weather is also expected to lead to greater variations in wheat quality in general and protein content in particular.

Already today, it is customary to compensate for low protein contents by the addition of wheat vital gluten, if no suitable blending wheats are available or they are too expensive. However, wheat gluten is also subject to fluctuations of availability, price and quality. In addition, the dosage calculated on flour is comparatively high (in the mill usually 0.5 - 2%) and thus transport and storage costs.

Standardized flour treatment agents and baking ingredients with the potential to replace all or part of the functionality of wheat gluten in spite of low dosage are therefore of great interest. Enzymes are of particular importance due to their multiple effects with high specificity of the single enzyme and extremely low dosage (about 0.001 - 0.01%, 10 - 100 g / t flour).

In particular, oxidases are attributed to a dough-stabilizing effect. Less well known is the fact that even hydrolytic enzymes such as xylanases increase the water binding and thus can stabilize the dough. For some years, enzymes from the group of carboxylester hydrolases (i. a. lipases) have gained great importance. They modify flour lipids in such a way that they stabilize proteins and the membranes of the gas bubbles and thus improve the gas retention – just as a higher gluten content would.

The presentation deals with the potential of enzymes and enzyme-based compounds to improve wheat flour with comparatively low protein content to achieve the properties of higher protein flours and to lower or avoid the addition of wheat vital gluten.

Keywords:
Standardization of Low Protein Wheat Flours, Enzymes, Mühlenchemie

FERMENTED AND MALTED MILLET PRODUCTS IN AFRICA: EXPEDITION FROM TRADITIONAL/ETHNIC FOODS TO INDUSTRIAL VALUE ADDED PRODUCTS

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With the prevalent food insecurity in Africa, there is a growing need to utilize the available crops to develop nutritious, affordable and palatable food for the populace. Millet is critical in this role, relative to its abundance in the continent and good nutritional composition. Millet is an important source of nutrients and an indispensable food for millions of people in developing countries such as Africa (Filli et al., 2010; Amadou et al., 2013; Mridula and Sharma, 2015). According to Joshi et al. (2008), millet is an important ecological food security crop known for its drought resistance and nutritional quality and can be an immediate subsistence food for a nutrient-scarce populace. For ages, fermentation and malting have been traditionally used to transform millet into variety of produce. A paradigm shift has however occurred over the years, giving birth to new commercially available products. This presentation thus appraises and gives an overview of traditional and modern fermented and malted products in Africa. Although, millet has been diversified to several products, its major food uses are still restrained to traditional consumers and largely remains underutilized. Considering the potential embedded in this grain, it is important to explore this crop through the application of appropriate modern fermentation and malting technologies. This will ensure the availability of ready to eat (RTE) and ready to use (RTU) food products and to a large extent address the incessant food security challenges plaguing Africa.

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Keywords:
Millet, fermentation, malting, food products

Parallel Session 3.1 – Cereal processing

EVOLUTION OF NIXTAMALIZATION PROCESS:ADVANTAGES AND DISADVANTAGES

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One important invention of man was the domestication of maize from a wild grass teosinte that took place about 9,000 years ago in Oaxaca, Mexico. The dispersion of maize in America's was enhanced by the nixtamalization technology that allowed fast distribution of the grain and its consumption later arround the world. Apparently, the nixtamalization seems to be useful for softening kernels and besides that use would carry no other importance. However, nixtamalization has important implications at protein level (solubilization, viscoelasticity, structure), starch (gelatinization, retrogradation (resistant starch type3 RS3)), as well as in lipids (saponification, stability) and from technological point of view the nixtamalization is a complex process that has several steps for ensuring quality of end-products. (1) Annealing at ≈35-48°C for producing thermo-resitant starch (RS2) for using in food systems with minimal formation of glue paste. (2) Doping with ions that changes pH and increases mineral fortification in products (Ca, Fe, K, Mg, Zn) and protects the starch granule with an armor of ions that inhibits enzymatic attact to it and has significant reduction of acrylamide formation in fat frying products. (3) Annealing at temperatures > 90°C during cooking and baking allows formation of amylose-lipid complexes (RS5-I & RS5-II) associated with prevention of diabetes-II, colon cancer, and obesity. In addition, Ca-nixtamalization imparts desirable functional properties in products and plays a vital role in prevention of pellagra, osteoporosis and aflatoxin reduction. Maize and wheat industries remove pericarp and bran from kernels because those fractions were undesirable for nixtamalized and refined flours. Today, with the problems of obesity, diabetes due poor fiber and complex carbohydrates in food systems the tendency is back to consume whole grain. The maize consumed today in Latin America had centuries of selection by texture, flavors, and aromas in products and adapting them for special cultural and culinary needs. The objective is to discuss in very general way the scientific aspects of evolution of maize (corn) processing technologies with emphasis in nixtamalization and to explain how the advantages and disadvantages of those technologies can help to solve some of the problems of the modern society.

Keywords:
Nixtamalization, maize, corn, resistant starch

VISCOELASTIC BEHAVIOR OF MASA FROM CORN FLOURS OBTAINED BY NIXTAMALIZATION WITH DIFFERENT CALCIUM SOURCES

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Several calcium sources can be used in the nixtamalization process to obtain corn flours. In this work, we used six calcium sources: wood ashes (> 60% $CaCO_3$), $Ca(OH)_2$, $CaCO_3$, $CaSO_4$, $CaCl_2$, and $Ca(C_2H_5COO)_2$, and its effect on the viscoelastic properties of corn masa was evaluated. One kg of commercial corn was cooked 35 min⁄94 °C in a water-calcium source solution at 1.0% (w⁄w). Nixtamal was milled to obtain masa which was dried, re-milled and sieved through a 0.5 mm mesh to obtain corn flour. Flour were rehydrated at 55% moisture content before analysis. The storage (G') and loss (G'') moduli of nixtamalized corn masa were assessed by the dynamic oscillatory test. OH^- ions from $Ca(OH)_2$ and some of them from the dissociation of wood ashes promoted the starch gelatinization, hydrolysis of pericarp into arabinoxylans, formation of amylose-lipid complexes, as well as more Ca-starch and Ca-zein interactions, leading the production of a more elastic and viscous masa. In contrast, nixtamalization with $CaCO_3$, $CaSO_4$, $CaCl_2$, and $Ca(C_2H_5COO)_2$ produce neutral-acidic conditions with ions reducing the degree of starch gelatinization and pericarp hydrolysis, which induced a reduced entanglement among the non gelatinized starch fractions with the other components, producing a weaker gel network. Nixtamalization with $Ca(OH)_2$ and wood ashes gave the best viscoelastic characteristics of masa for tortilla production.

Keywords:
nixtamalization, calcium-starch interactions, viscoelasticity, gelatinization

THE EFFECT OF MILLING DEGREE ON RICE QUALITY

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The milled rice yield from brown rice is usually lower than 85% now in China. Excessive milling process caused a huge resource waste of grain as well as energy. The effects of different milling degrees on rice quality, including nutritional properties and taste score were investigated with rice materials from milling industries and those made in the lab in this study. The results indicated that with the improvement of milling degree, the rice taste value showed a downward trend after increase first, and when controlling the milled rice yield to the range of 88% to 92%, the taste value reached the highest. The content of VE and VB were negatively related to rice milling degree. Rice whiteness, amylose content and protein content increased as the milling degree improved when the milled rice yield higher than 85% and kept steady at a yield lower than 85%. Therefore, we consider it feasible to improve the rice quality by increasing the milled rice yield within a reasonable range and, as the taste value reaches the highest, nutrient levels could also be maintained from 40% to 75% of husked rice, which is significantly higher than the current market level. In addition, excessive polishing may reduce rice eating quality. As reduced milling and polishing will help to reduce energy consumption, so energy consumption per ton of rice could be one of the indicators to evaluate the rice milling degree. Based on it, milling degree control could be realized with the balance between milled rice yield and whiteness.

Keywords:
Rice processing, Milling degree, Rice taste quality, Milled rice yield

ISOLATION AND IDENTIFICATION OF LACTIC ACID BACTERIA AND YEASTS IN TYPE I SOURDOUGHS WITH FOCUS ON TRADITIONAL AUSTRIAN SOURDOUGHS

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Sourdough fermentation of bread exhibits major advantages, like improved baking properties, nutritional benefits, and superior shelf life and sensory quality. Traditional sourdough is characterized by the absence of starter cultures and its regular propagation and back-slopping.

In Austria, data on the diversity of lactic acid bacteria (LAB) and yeasts in traditional sourdough are still lacking. Therefore, the aim of this study was to characterize the microbiota of Austrian type I rye and wheat sourdoughs. The samples analysed were not intended for commercial reasons, but were obtained from artisan bakeries as well as households.

For the enumeration and isolation of sourdough lactic acid bacteria, six specific culture media were used. The enumeration results varied from less than 10^6 cfu g^{-1} to more than 10^9 cfu g^{-1}. Compared to yeasts, LAB were present in sourdoughs at a ratio of 1:10 to 1:100. Due to different morphologies, LAB colonies were selected and identified to species level by 16S rDNA-sequencing. The detected species belong to five genera of lactic acid bacteria: *Lactobacillus*, *Weissella*, *Leuconostoc*, *Pediococcus*, and *Streptococcus*. Within these genera, *Lactobacillus* showed the highest diversity. Based on rep-PCR typing a wide range on strain level was detected. The yeasts isolated from the sourdoughs were identified on species level by 26S rDNA-sequencing. Isolates belong to the genera *Saccharomyces*, *Candida*, *Pichia*, and *Kazachstania*. RAPD-PCR based typing results displayed a high diversity on strain level.

This approach has revealed a previously unknown diversity of especially lactic acid bacteria in traditional Austrian sourdough. However, further analysis are necessary for precise characterization of sourdough LAB and yeasts to tailor sourdoughs for excellent bread quality.

Keywords:
Traditional sourdough, Lactic acid bacteria, Yeasts, Identification

POTENTIAL OF ISOLATED ARABINOXYLANS TO IMPROVE THE FUNCTIONAL PROPERTIES OF GLUTEN-FREE BREAD

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Arabinoxylans are the most important thickening agents and key components for bread making in rye due to their high viscosity and molecular weight. Thus, rye arabinoxylans could be very promising for application as baking improvers in gluten-free bread. Depending on their extraction conditions, their structure and subsequently their functionality can be affected. By combining customized arabinoxylans with tailored oxidizing enzymes (e.g. pyranose 2-oxidase), arabinoxylan cross-linking can be supported. The aim of this study was to determine the potential of different arabinoxylan isolates and⁄or pyranose 2-oxidase to improve the functional properties of buckwheat and millet bread. Results show that greater functional properties were achieved by combining arabinoxylans and pyranose 2-oxidase in buckwheat bread, while a higher improvement was reached in case of millet when only arabinoxylan was added. The addition of different arabinoxylans significantly affected the technological bread properties, which probably depended on the chemical structure and functionality of every isolate. These outcomes indicate that arabinoxylans could be applied as natural structure-forming agents in gluten-free bread.

Keywords:
gluten-free bread, buckwheat, millet, rye arabinoxylans

APPLICATION OF FICK'S SECOND LAW TO STUDY THE MECHANISM OF OIL UPTAKE AND WATER LOSS DURING DEEP-FAT FRYING OF TORTILLA CHIPS

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Deep fat frying is one of the most important unit operations in food processing and a traditional cooking method to achieve desirable sensory attributes such as flavor and texture in variety of foods. As people are becoming more health conscious and pursuing healthier food, the trend of consumers has been changed to low-fat fried food over the past years. A better understanding of relationship to different parameter of the deep fat frying should provide ways to optimize the frying process, thus controlling oil pickup. Nixtamalization with lime and without lime and different particles sizes were evaluated using exponential equation $Mt/M\infty=Kt^n$ to describe water release and oil absorption mechanisms during frying tortilla chips, where n is the diffusional exponent characteristic of the mechanism. For Fickian mechanism the exponent (n) is ≤0.50 for slabs. Moisture releases from tortilla chips with lime showed Fickian (n=0.4575) and non-Fickian mechanism n=0.5973 without lime. The oil absorption showed a Fickian mechanism for nixtamalization with lime n=0.3950 and for nixtamalization without lime n=0.2888. Regarding the particle size, oil absorption followed the Fickian mechanism for fine particle n=0.4539 and for coarse particle n=0.3743, but water release presented non-Fickian mechanism with n=0.7076 for fine particles and n=0.6903 for coarse particles. Larger water diffusion coefficient in tortilla chip compared to the oil diffusion indicates that water release and oil absorption during deep frying is not a simultaneous event.

Keywords:
Fickian mechanism, Diffusion coefficient, Water release, Oil absorption Nixtamalization

Parallel Session 3.2 – Breeding & agronomy

RELATIONSHIPS BETWEEN GRAIN YIELD AND PROTEIN QUANTITY AND QUALITY IN COMMERCIAL WHEAT

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Grain yield and baking quality are the primary selection parameters in wheat improvement. Often breeding programs are faced with conflicting interests as grain yield and grain protein content are often negatively associated. The objectives of this study were to determine, for the three production regions in South Africa, the relationship of grain yield with flour and grain protein content, and loaf volume; and to establish the relationship of grain yield with soluble and insoluble gluten protein fractions in cultivars with high, medium and low yield. Commercial wheat cultivars produced in the three production regions of South Africa were tested at two representative locations for two consecutive seasons, and subsequently divided into groups with high, medium and low yield. Environment had a large influence on yield and quality characteristics. The only significant negative correlation between grain yield, and flour and grain protein content, was in the lowest yielding group of the irrigation cultivars, so generally there was no significant negative relationship between grain yield and flour and grain protein content. Grain yield and loaf volume were highly significantly correlated in the high yielding cultivar group of the rainfed summer rainfall region. Correlations between grain yield and soluble and insoluble fractions in total protein were inconsistent but were the most significant in the low yielding irrigation cultivars.

Keywords:
grain yield, protein content, protein quality, loaf volume

THE INFLUENCE OF NITROGEN AND PHOSPHOROUS DEFICIENCY ON PROTEIN QUALITY AND QUANTITY IN TWO BREAD WHEAT CULTIVARS IN SOUTH AFRICA

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Optimal nutrient supply is indispensable to produce wheat of good quality and yield. Nitrogen (N) plays a fundamental role in enhancing the productivity of crops, while phosphorous (P) is required for optimum growth and reproduction. Inadequate nutrient supply is a stress factor for plants, which has been found of significant importance in protein quality and quantity. The aim of this study was to examine the effect of low N and P supply and a combination of the two on flour protein content (FPC), sodium dodecyl sulfate sedimentation volume (SDSS) and quality of protein determined with size exclusion high performance liquid chromatography in two high quality South-African bread wheat cultivars (PAN3497 and SST806). Protein contents and SDSS were highly influenced by treatments. Low N and a combination of low N and low P treatment caused a significant decrease in protein content and SDS volume of both cultivars. SDSS value varied from 44 to 78 ml, and FPC from 8 to 20 in samples. It can be interpreted from the role of N in protein synthesis in plants. Statistically highly significant correlations between SDSS value and FPC were seen in PAN3497 (r=0.89) and SST806 (r=0.97). SDS soluble large monomeric proteins (LPP) were significantly increased by low N stress in both cultivars, and SDS insoluble LPP were significantly decreased by a combination of low N and low P treatment in PAN3497. Low N treatment had a significant effect on SDS soluble and insoluble SPP, LMP and SMP in both wheat cultivars. Low N supply had the largest effect on protein quality and quantity, and also a large genotype effect was found.

Keywords:
abiotic stress, nutrient deficiency, protein, wheat quality

PERFORMANCE OF HEXAPLOID WHEAT (*Triticum aestivum*) IN CHINA REFLECTED BY CHANGES IN GENOMIC DNA COMPOSITION

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Agronomic performance of 230 hexaploid Wheat (*Triticum aestivum*) landraces and commercial cultivars was evaluated for three years in Taigu (belongs to north China wheat zone), Linfen and Yuncheng (Huanghuai wheat zone) including plant height, flag leaf length, leaf angle, spike length, grain numbers per spike, 100 grains weight and yield. Modern cultivars showed 30-70% yield increase coupled with shorter stature and erecter leaves compared to landraces.

Tackling the wheat genomic information has been a huge challenge. By deploying a simplified approach-genomic DNA SLAF-seq (GBS with EcoRV-HF®+ScaI-HF®) we obtained 1,605,735 polymorphic SLAF marker and 6,003,244 SNP markers in total. Genome-wide association studies identified SNP markers linked to important agronomic traits including plant height, spike length and grain weight. These markers have been improved by incorporating RNA-seq data and genomic resequencing data of representative cultivars and EMS-induced mutants and could be valuable for further breeding use. Genomic regions connected to domestication and improvement of wheat will be identified by macrodata analysis of available genomic resources.

Acknowledgement: This study was supported by Shanxi Provincial Natural Science Foundation (2014011004-1), Natural Science Foundation of China (31101199, 31470285), Shanxi Provincial 100 talents program (Shanxi Organising Bureau 2014-18).

Keywords:
GWAS , wheat, SLAF marker, agronomic performance

DEVELOPMENT AND CHARACTERISATION OF WHEAT WITH LOW-VISCOSITY GRAIN EXTRACTS USING NOVEL ALLELES OF IRX9 ORTHOLOGUE TAGT43_2.

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Viscosity of extracts from wheat grain is a detrimental trait for non-food uses, leading to sticky deposits resulting in down-time for whisky distilleries and necessitating enzyme treatment in animal feed. In wheat (unlike barley) extract viscosity is almost entirely due to the soluble fraction of the cell wall polysaccharide arabinoxylan (AX). We have shown that suppression of genes responsible for synthesis of AX can decrease extract viscosity by 6-fold using RNAi driven by an endosperm-specific promoter [Freeman et al., 2016, Plant Biotech. J. 14: 109-116]. In order to develop a non-GM variety with the low viscosity trait, we decided to look for non-functional alleles of these genes using TILLING. However, AX is a vital component of every cell wall in wheat so we needed a gene target where constitutive knock-out would only affect the grain tissues that produce the water-extractable AX (WE-AX) responsible for viscosity. From expression data, we selected TaGT43_2 as a suitable target; TaGT43_2 is one of several orthologues in wheat to IRX9, a glycosyl transferase 43 family gene required for xylan extension in Arabidopsis. Using high resolution melt analysis approaches [Botticella et al., 2011 BMC Plant Biol. 11, 156], we identified alleles with premature stop codons in all three homeologues of TaGT43_2 in the mutagenised Cadenza population. We crossed lines carrying these alleles and selfed them to produce lines with homozygous stacks of aabbDD, AAbbdd, aaBBdd and aabbdd mutants. We found that the amounts of WE-AX and extract viscosities from the grain of these lines were significantly decreased in one of the double stacks and substantially decreased in the triple stack. We are currently studying these triple stack plants in more detail to characterise transcriptome and cell wall effects. Limagrain have introduced these novel alleles into their elite breeding streams and are backcrossing to minimise background mutations. We will be yield testing the MAS converted lines for any negative pleiotropic effects. We are on course to deliver one of the first new wheat varieties developed using reverse genetics.

Keywords:
Tilling, Low Viscosity, MAS, IRX9

DEVELOPMENT OF WHEAT GENOTYPES WITH HIGH BISCUIT-MAKING QUALITY AND EVALUATION OF BISCUIT-MAKING QUALITY OF LANDRACES

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Turkish biscuit sector is a high value-added with high export ratio has grown substantially over the fifteen years. Soft wheat required by the sector, with low protein quantity and quality, are not produced sufficiently in Turkey. It is therefore essential to develop high quality soft wheat varieties suitable to the environmental conditions of Turkey to meet the increasing raw material demand. This study is a part of project funded by the Scientific and Technological Research Council of Turkey. The project aims (i) developing new soft wheat genotypes with good biscuit-making quality and superior agronomic characteristics and (ii) evaluation of landraces in terms of the traits related to biscuit-making quality and supplying new genetic resources to the breeding programs. In this project a total of 40 promising homozygous wheat lines (20 for rainfed and 20 for irrigated conditions), developed by crossing of genotypes with high biscuit-making quality, are used. Rainfed trials are conducted in seven and irrigated trials in five locations during 3 years. Grain, whole meal, flour, gluten and dough quality parameters, grain yield, some morphological and disease parameters are evaluated. Additionally, in the study 200 promising landraces are evaluated for using as a crossing parent material. In this genotypes besides agronomical and diseases properties physical, chemical and dough rheological properties are measured. High Molecular Weight (HMW) glutenin subunits and rye translocations of genotypes are also determined. In this study two years results of project are summarized. In the first-year drought conditions were occurred but enough precipitation was taken in rainfed conditions in the second year. To see the baby type and petit beurre biscuit-making potential 6 promising lines both rainfed and irrigated conditions were sent to a biscuit company. Twenty landraces were selected and will be evaluated in the last year. The candidate varieties developed by this project will help the raw material demand of the biscuit industry and thus contribute to the national economy and the selected landraces will be used in breeding programs.

Keywords:
Biscuit wheat, variety, breeding, landraces

OPTIMIZATION OF MUCILAGE EXTRACTION OF CHAN SEEDS (*Hyptis suaveolens* (L.) POIT) BY MECHANICAL AGITATION USING A BOX-BEHNKEN DESIGN

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Chan seed (*Hyptis suaveolens* (L.) Poit) belongs to Lamiaceae family and the seeds group known as chias that have developed an important role as a food resource in pre-Hispanic tribes in Mexico. An interest characteristic of these seeds is the production of mucilage which in hydration exudes and is agglutinated on the surface. It is known that the mucilage has in its molecule units of fucose, xylose, mannose, galactose, glucose and 4-O-methylglucoronic acid. The potential as a food additive for these mucilages and gums as a group of natural polymers is because of its functional properties.

Extraction of interesting components of natural resources is a useful technique in terms of productivity, processing time, energy and yield. Response surface methodology (RSM) allows the processes optimization reducing the number of experiments and evaluating the independent factors that has an individual effect and the interactions of the parameters in the desired response.

The aim of this study was to use the Box-Behnken experimental design to determinate the influence of the solid-liquid ratio, the time and temperature in the optimization of chan seed mucilage extraction by mechanical agitation using a Rushton propeller. The results show the optimization of the process employing a solid-liquid ratio of 1:40, shaking during 14.1 minutes and a temperature of 50 °C. The comparison of the prediction values against the experimental ones of each response was not statistically significant therefore this experimental design and the polinomial models are useful for the optimization in the chan seed mucilage extraction.

Keywords:
seed, mucilage,extraction ,response surface methodology

Parallel Session 4.1 – Innovations in cereal ingredients and processing for novel and healthful foods (organized by KSU)

UNIQUE PROPERTIES AND APPLICATIONS OF WAXY WHEAT FLOUR AND STARCH

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To realize the full potential of waxy wheat in food applications, we have investigated (1) dry-milling of waxy wheat, (2) dough properties of waxy wheat flour, (3) pasting properties of waxy wheat flour as well as factors governing the pasting properties, (4) methods to improve functional properties of waxy wheat flour, (5) wet milling of hard waxy wheat flour into gluten and waxy wheat starch, (6) gelatinization and pasting properties of waxy wheat starch, (7) chemical modification of waxy wheat starch, and (8) applications of waxy wheat in bread and extruded products. The milling quality of waxy wheat was evaluated by comparing its flour yield, chemical composition, flow properties, and particle size distribution with that of two normal hard red winter (HRW) wheats using two laboratory milling methods. The tempering characteristic of waxy wheat was remarkably different from that of normal HRW wheat. The flour yield of waxy wheat was significantly lower than that of normal wheat. Waxy wheat flour was less free-flowing than the normal HRW flour, mainly due to its smaller particle size and higher fat content. Tempered waxy wheat flour could not be effectively sieved after milling. In addition, waxy wheat flour had a higher starch damage content due to higher flour adhesiveness and fragility of starch granules compared to normal HRW wheat. Doughs prepared from six waxy hard wheat flours were found to be weaker than those of from normal wheats. Waxy wheat flour had higher water absorption and lower mixing time than normal wheat flour. Substitution (< 30%) with waxy wheat flour resulted in higher loaf volume and softer loaves. Incorporation of waxy wheat flour resulted in softer bread immediately after baking but did not retard staling upon storage. Cross-linked waxy wheat starch (WWS) gelatinized and cooked to a thick non-cohesive paste at a relatively lower temperature compared to cross-linked waxy maize starch (WMS), and its paste re-associated less than cross-linked WMS. Such properties increase the market potential of cross-linked WWS as a thickening agent. Modified WWS would offer better performance in frozen food products.

Keywords:
waxy wheat, wet milling, chemical modification, properties of waxy wheat flour

INDIRECT CONTINUOUS HEAT TREATMENT OF WHEAT GRAIN AND WHOLE WHEAT FLOUR

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Thermal energy has been used in processes like heating and cooling to preserve and protect food for a long time. High temperature applications are mostly used to kill pathogens, spoilage microbes, inactivate enzymes. Other beneficial functions of heating include improvement in flavor, texture and color. The primary effect of heat treatment is denaturation of the proteins, partial reduction or inactivation of alpha-amylase and partial gelatinization of the starch. Understanding of relationship between heat transfer, thermal properties of food, heating medium, thermodynamics and the functionality of the resulting heat treated flour is of critical importance for the food processor. The overall objective of this study was to investigate the effects of direct, rapid and continuous thermal processing techniques on the functionality of wheat flours. The specific objectives were to characterize the heat treated flours for their mixing, pasting, and baking performance; and explore the potential use of these new products in dough and batter-based food formulations. Whole wheat flour or whole wheat grain hydrated to12, 16 and 20% moisture was subjected to indirect heat treatment at 75, 85 and 95°C for 0.5, 1.0 and 1.5 min via a steam jacket thermal heat processing unit. Treated whole wheat flour (TWWF) and treated grain whole wheat flour (TGWWF) samples were analyzed for their mixing and pasting profiles using the MixoLab for protein molecular size distribution by size exclusion-HPLC. Treated flours were subjected range of characterization tests including particle size analysis, proximate analysis, water holding capacity and solubility, pasting (RVA), degree of gelatinization (DSC), relative crystallinity (X-ray diffraction). Treated samples had lower pasting viscosity, lower crystallinity, and higher solvent retention capacity than control (untreated) flours. Treated flour was not able to develop into viscoelastic dough. Mixing time decreased with increase in treatment moisture and temperature. There was decrease in total extractable proteins compared to control. Adverse effects increased with increase in thermal and mechanical energy inputs, both of which were influenced by treatment temperature, residence time and moisture. Moisture and temperature were the most significant factors that influencing properties of starch in treated flours. These effects were more pronounced in treated whole wheat flour compared to treated whole wheat grain.

Keywords:
wheat grain, whole wheat flour functionality, heat treatment

UTILIZATION OF SORGHUM AND MILLETS IN EXTRUDED PRODUCTS

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This presentation focuses on processing of sorghum and millets in low moisture extrusion based snacks and infant cereal applications.

A 2×5 factorial study was implemented for extrusion of two blends of sorghum flour and corn flour (6:1 and 5:2 w⁄w ratios) as controls, and also with three different sources of protein - whey protein isolate, defatted soy flour and mixed legume flour - added to the sorghum⁄corn flour blends at 30%. A 50:50 blend of defatted soy flour and whey protein isolate was also added at 30% to the sorghum⁄corn flour blends. These ten formulations were processed on a pilot-scale twin-screw extruder to investigate relationships between sorghum⁄corn flour ratio and protein addition, and the attributes of resultant brittle foams such as expansion, microstructure, mechanical properties and sensory properties. Expansion ratio increased at the higher level of corn flour, and decreased with the incorporation of protein sources. Extrudates with defatted soy flour had a lower expansion ratio (5.3–5.4) than those with whey protein isolate (7.7-7.9), legume flour (7.1-9.9) or whey protein isolate-defatted soy flour (6.1–6.9). Foam microstructure, obtained by X-ray microtomography, corresponded well with expansion. Extrudates with defatted soy flour had lowest cell diameter. Average crushing force (40.9-154.9 N) was lower for higher level of corn flour. However, contrary to expectations, crushing force and crispness work both decreased with incorporation of protein sources. This indicated a matrix weakening effect, and will be elaborated in the presentation. Consumer acceptability results will also be discussed.

A second study developed complementary foods using extruded sorghum and rice in combination with legumes Bengal gram, green gram and soybean on lab-scale twin screw equipment. Physico-chemical attributes and acceptability of the extrudates and resultant porridge blends were evaluated with and without combination with malted finger millets at 15%. The mixes were made into porridge and tested for viscosity using a Brookfield viscometer. Porridges were also fed to the infants and acceptability to mothers recorded. The complementary mixes with malted finer millets showed reduced viscosity, formed good, smooth slurry, and were well accepted both by children and their mothers.

We'll describe challenges to making nutritious and protein-rich products using non-traditional grains acceptable to target consumers and how to address them using knowledge of fundamental macromolecular changes and interactions between starch, protein and other components, as well as extrusion process conditions such as shear or mechanical energy.

Keywords:
Sorghum, millets, infant cereal, extrusion, protein

RECENT INNOVATIONS IN EXTRUSION SYSTEMS FOR WHOLE GRAIN EXPANDED SNACKS

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Whole grain ingredients are wholesome and healthier, but incorporating them in snacks involves challenges such as retention of distinctive taste, shape and crunch of the traditional product that consumers know and love. It also involves manufacturing challenges as standard extrusion equipment may not be capable to handle the compositional differences in whole-grain relative to refined meals, leading to processing limitations or process failures. This is the case of the disk-die extruder, also known as random extruder. The random extrusion process produces puffs snacks with unique crunchy texture and performs very reliably with refined cereal meals, but it encounters serious performance issues with whole-grain meals. This presentation describes the redesign of random extrusion processing with twin-auger conveyance to enable production of extruded crunchy puffed snacks with 8-grams whole-grain cornmeal⁄serving or larger whole-grain content. It also discusses the application of first principles, as well as key challenges faced and overcame during the design. The newly patented process described in this presentation will not only allow the manufacture of crunchy extruded puffs with whole-grain rich raw materials, but it will also open the door for ingredient innovation on random extrusion.

Keywords:
whole grain, random extrusion, puffed snacks

USAGE AND BENEFITS OF DEACTIVATED YEAST AS AN ALTERNATIVE REDUCING AGENT IN INDUSTRIAL BAKING

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Deactivated dry yeast (DDY) acts as a reducing agent in dough that helps to improve machinability and tolerance to sheeting during manufacturing. DDY is yeast that has been heat treated and can no longer undergo fermentation. This ingredient can be added to a variety of products including flour tortillas, hamburger buns, laminated doughs, and white pan bread. DDY enhances extensibility in the dough because the yeast cell contains naturally occurring glutathione that acts on the disulfide bonds found in the gluten. It is well suited for products that are looking to be more consumer friendly as it can be labeled as either deactivated yeast or just yeast. The benefits of using DDY in bakery applications include providing relaxation to the dough, making it more extensible, maintains shape and weight consistency in the final product, improve temperature control in frozen dough, and can help reduce overall mix time. Dough development is very dependent on the ability to create a visco-elastic dough and due to environmental factors, flour properties can often change. For the industrial bakery, it is very important to maintain consistency during manufacturing as some processes can apply increased stress to the dough, which can alter the characteristics of the final product. The use of DDY helps to maintain uniformity during processing starting at the beginning of mixing all the way through to the final proof. This can be an advantage to the baker, as shortened mixing time can lower the dough temperature helping to control the speed of fermentation during processing as well as reduce the amount of ice used during mixing. DDY can be an alternative for protease and L-Cysteine (L-C) as the relaxation performance is measured on an equivalent ppm scale to L-C. Another benefit to DDY, as compared to other reducing agents, is that the effects are only seen with applied force, which minimizing changes that occur beyond the mixing bowl because it is not a continuous reaction. This can be a great benefit during stops in production or issues during manufacturing. DDY can also be used in products like pizza that require a consistent thickness and pan diameter as it helps to prevent dough shrinkage. In addition to improving machinability, certain types of DDY can also help to improve and enhance the yeast and fermentation flavor in dough. Because of the benefits that DDY provides during manufacturing and being that it is a more label friendly reducing agent, it makes this ingredient a suitable alternative when looking for process optimization and final product consistency.

Keywords:
Deactivated dry yeast, industrial baking

Parallel Session 4.2 – Quality assessment: Dedicated to Dr. Walter Bushuk

A SCREENING PROTOCOL FOR WHEAT FLOUR WATER ABSORPTION, DOUGH MIXING REQUIREMENT AND VISCOELASTICITY

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Flour dough properties, which include water absorption, mixing requirement, and viscoelasticity, are critical in determining wheat processing performance and end-product quality. A common practice involves milling to prepare enough flour for farinograph, extensograph or other tests for rheological properties of dough. However, the traditional protocol requires large amounts of wheat (2-5 kg) for milling and testing throughput is minimal due to the time-consuming tests for dough properties. The purpose of this study was to develop a new test protocol which can significantly reduce wheat sample requirement and increase throughput for measuring flour water absorption and dough viscoelasticity.

Wheat samples were milled using a Quadrumat Junior (QJ) laboratory mill with modification. To improve milling efficiency and optimize flour extraction rate, the reel sifter originally supplied with the QJ laboratory mill was removed, and the obtained whole meal was sifted through a Bühler MLUA GM sieve to remove bran and yield white flour.

To predict flour water absorption, the Brabender GlutoPeak instrument was used. It is a shear-based method which requires 8 g of flour and less than 10 min per test. Highly significant positive linear relationship (r^2 = 0.97) was found between GlutoPeak maximum torque and farinograph water absorption for 83 flour samples. Flour prepared either with the Bühler test mill or QJ mill can be used for predicting water absorption effectively. GlutoPeak maximum torque was found to be independent of dough strength (r^2 = 0.02) as measured by extensigraph. The GlutoPeak test can be a powerful tool for rapid and reliable prediction of water absorption of wheat flour.

For measuring viscoelastic properties of dough, flour (100g) prepared with the QJ mill was mixed with a Swanson type pin mixer to develop dough. The dough was subsequently stretched by an extensograph after 15 min of floor time and 30 min resting. Strong correlations were found for both Rmax ($r > 0.93$, $p < 0.001$) and extensibility ($r > 0.64$, $p < 0.001$) for the proposed rapid extensograph method with the standard extensograph method. Additionally, the mixing parameters (time and energy) obtained during dough preparation provided further information about dough strength and mixing requirement.

The proposed combination of QJ mill⁄GlutoPeak⁄Rapid Extensograph for wheat quality analysis is powerful and reliable. It requires as little as 200 g of wheat sample for predicting water absorption and conducting the extensograph test. The throughput is four times more than the traditional protocol which requires a farinograph test for water absorption and long dough resting time for the standard extensograph. The new protocol can be widely adopted in the flour industry and meets the need for a fast evaluation of dough strength in breeding trials.

Keywords:
Wheat Quality Evaluation; Milling Performance; Water Absorption; Dough Viscoelasticity.

QUALITY CHARACTERISTICS OF U.S. SOFT WHITE AND CLUB WHEAT

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U.S. soft white wheat from the Pacific Northwest states of Washington, Oregon and Idaho is a premium quality, versatile soft wheat. Soft White wheat (SWW) is comprised of winter and spring-sown varieties; spike morphology further delineates the class into 'common' (lax) and club sub-classes. The region produces approximately 5.5 mt annually. The majority is available for export. Typical quality characteristics are high test weight (80.9 kg⁄hL), moderate protein (10.5%), high break and straight-grade flour yields with low ash (42.6%, 64.6%, 0.33%) (modified Quadrumat Senior). Gluten strength varies from weak to moderately strong (Farinograph development time 1.2-1.9 min, stability 0.9-12.9 min). Club wheat, however is bred to have very weak and extensible gluten (Farinograph development time 0.7 min, stability 0.5 min). Key quality criteria include low Water (50.7-60.1%, mean 53.9%), Sucrose (84.2-104.6%, mean 92.6%), and Na carbonate (59.6-73.4%, mean 63.9%) Solvent Retention Capacities (SRC), with variable Lactic Acid SRC (68.9-133.1%, mean 104.2%). Breeding line selection criteria emphasize AACCI cookie diameter and sponge cake volume. Further, breeding lines are selected for low PPO via L-DOPA assay. Lastly, although most varieties have 'normal' levels of starch amylose, some carry the 4A null with reduced amylose content. Pacific Northwest soft white wheat is a versatile, premium quality soft wheat.

Keywords:
soft white wheat, solvent retention capacity, club wheat, cookie diameter

NEW SOLUTIONS TO AUTOMATE AND OPTIMIZE QUALITY CONTROL AND LAB ANALYTICS

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Measurement of grain- and flour quality is in many fields in the value added chain grain-flour-semi-finished product-end product a key factor for the production of all kind of baked goods, which complies with customer demands. In the past years, that required from the laboratory analyses, procedures which provide results more rapidly and if possible run fully automated. This is a result beside others, of the fact that production volume increases, but the laboratory capacities are not adapted adequately. This leads to the fact, that the required analyses are needed more quickly, by often short personnel.

In order to cope with that requirement Brabender has enlarged its portfolio, respectively improved existing systems by process simplification and automization during the past years.

A new generation of the Farinograph works with a web-oriented software the MetaBridge. It enables an easy operation of the instrument and builds bridges for new applications. Now it is possible to automatically transfer analyses data by WLan/Lan to most in-house LIMS systems. Furthermore the test results and diagrams can be displayed online and live on every smartphone or tablet. A special attachment for the mixer enables tests with the Farinograph-TS of gluten free flours (e.g. maiz- and rice flour). The add-on module Aqua-Inject provides automated titration curves for defining the waterabsorption and calculates the relating value.

The GlutoPeak provides a quick baseline investigation for describing the gluten quality of grain and flour, using the newly developed Rapid-Flour-Check evaluation. Within a couple of minutes you get a “rheological fingerprint” providing information in regards to gluten- quantity and quality, the protein content, and the anticipated waterabsorption. Also available are special methods for vital gluten and whole meal flour.

A precise and rapid determination of moisture belongs also to the standard test of every quality control. The Moisture Tester MT-CA measures in accordance with general reference methods up to 10 material samples, saving time due to highly automated working processes. The embedded MetaBridge concept, also provides here the advantages which were already described with the Farinograph-TS.

Brabender – New solutions to automate and optimize quality control and lab analytic

Keywords:
Farinograph, GlutoPeak, Laboratory, Titration

PREDICTION OF QUALITY CONTROL PARAMETERS OF WHEAT AND WHEAT FLOUR

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Wheat and its end-products such as bread, pasta, cake, etc. is one of the most consumed food in all over the world. It is very important to determine the wheat quality because of two main reasons. First reason is the price of wheat is decided according to its quality. Second reason is end-product quality is directly related to wheat and wheat flour quality. The quality of wheat and wheat flour should be controlled at every step of production line (from sampling to obtain end-product). It can be estimated according to different quality parameters. These quality parameters are classified as chemical, physical, physicochemical and rheological quality parameters and they are determined by using experimental methods. However, these methods take time to get results and most of the analysis cause damage on the samples. Recently, new methods are developing to prevent time and sample loose while carrying out analysis. One of them is Near-Infrared Spectroscopy (NIRS) associated with chemometric methods such as Artificial Neural Network (ANN), Partial Least Squares (PLS). NIRS technique calibrated with experimental methods has begun to be used to predict the wheat and wheat flour quality parameters. NIRS is based on the absorption of electromagnetic radiation. Chemical bonds have the different absorption levels. It gives us information about the wheat and wheat flour content depending on absorption level. The study shows that NIRS is a very good way to predict the quality parameters of wheat and wheat flour. Protein, moisture, gluten and ash content and Zeleny sedimentation value of wheat and wheat flour was investigated to determine by using NIRS coupled with PLS. The wavelength range for this study is between 900-1700 nm.

Keywords:
Wheat; Wheat Flour; NIRS; Quality Control; Quality Parameters

CEREAL CHEMISTRY RESEARCH IN A SMALL COUNTRY: STRATEGIES TO MOVE ON

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Uruguayan wheat is less than 0.2% of world production in average years. However, for this 3.4 million people country, wheat is not only the main source of calories, but also it is very relevant for its economy. Therefore, its production should be competitive in an open market. In this context, research on local wheat quality becomes crucial and limited resources should be optimized. Without a critical mass of people working in wheat quality science, the selected strategy was the search for local and international partners. In the late 90s, the National Wheat Board was created and became a relevant actor. Wheat quality research started in the late 20s, to support the oldest South American breeding program; this program is still active and it is essential to have local genotypes that meet market requirements. Regional integration was used to understand how genotype-environment interactions affect the always-controversial relationship between performance and quality. Application of biotechnological tools is more important each day; research on the application of genomic selection on wheat quality was possible thanks to local and international integration. Both applied and basic science are needed. Exporters established that the main limitations to trade wheat were mycotoxins content, wheat classification and harvest survey reports; a private sector funded project is undergoing to solve these issues. Local gluten characteristics, and their relationship with rheological properties, were studied by SE-HPLC. The influence of pentosans on breadmaking quality was studied in several projects thanks to the partnership with a local Faculty of Chemistry. As wheat is the most important food, the National Wheat Board called nutrition scientists to work on this grain; as a result, not only local breads were characterized, but also the nutritional properties of Uruguayan wheats were determined, including micronutrients. A proactive attitude helped to include more scientists in wheat research, covering a wide range of research topics.

Keywords:
Quality assessment, nutrition, breeding, Wheat classes

VARIATION OF GLUTEN QUALITY- AND QUANTITY-INDUCED CHANGES VIA THE GLUTEN STRUCTURE IN RELATION TO VISCOELASTIC PROPERTIES

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The use of vital wheat gluten as dough enhancer in the breadmaking industry is widely known especially in whole wheat product. The objective of this study is to examine the fundamental rheological properties of gluten extracted from six commercial wheat flours containing four gluten products (GA, GB, GC and Gliadin) at two substitution levels (3 and 6%). Each gluten product modified characteristics of commercial wheat gluten differently based on its acidity, charge to size ratio, strength and deformability. Results from creep-recovery (small deformation) and compression-recovery (large deformation) tests were fitted into Burgers model ($r^2 > 0.999$, $P < 0.001$). GA and GC increased rigidity of commercial wheat gluten after increasing level substitution in both tests. However, gluten products with more acidity increased gluten deformation presumably by increasing repulsive forces in the gluten structure. GB (pH 4.2) altered commercial wheat gluten properties by acting as a plasticizer, similar to gliadin substitution, and decreased gluten deformation up to 64% in the creep-recovery test. Gluten strength (Ɛ0) increased up to 22% with the substitution of GA and GC as evaluated in the compression-recovery test. Redundancy analysis (RDA) revealed that the gluten samples were separated in terms of their strength and deformability after treatments. Gluten of commercial wheat flour with GA and GC substitution had a positive correlation to parameters describing strength mostly from the large deformation compression-recovery test, while the substitution of GB and Gliadin in commercial wheat flour were more correlated with the small deformation creep-recovery test.

Keywords:
Creep-recovery test, compression-recovery test, gluten rheology, redundancy analysis (RDA)

UNDERSTANDING THE FUNCTIONAL PROPERTIES OF STARCH FROM THE "MALANGA" GROWN IN CUBA. COMPARISON OF STARCH FROM CORMS AND CORMELS

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Malanga *(Xanthosoma spp*.), the name used in Cuba to refer the different edible species of Aráceas*,* is a tropical crop largely produced for its underground corms and cormels. In 2014, the top three producers were Cuba (142,032.52 tonnes), Venezuela (70,670.71) tonnes) and Nicaragua (49,603.43 tonnes).

Post-harvest utilization of malanga is still limited and there is little information about the use of this rhizome as flour or starch (Falade *et al*. 2013). Despite its industrial, nutritional and health properties, the malanga has not gained sufficient research attention to enhance its potential as raw material. Therefore, from economical and nutritional point of view, it would be interesting to expand the knowledge about this rhizome and extend its application, which would decrease its post-harvest losses (Himeda *et al*. 2012).

The starches has different applications in food industry as thickener, colloidal stabilizer, gelling, bulking and water retention agent (Dura *et al*., 2014). However, there are plenty of starch sources that remain unexplored and could offer great alternatives for the food industry.

The aim of this work was to evaluate the potential of corms as a source of starch and the comparison of the functional properties of the starches from the corms and cormels of the same species(*Xanthosoma* spp). For that purpose, starch from corms and cormels was isolated and then they were characterized from the functional and morphological point of view.

Color of starch from corms and cormels showed significant differences. Specifically, color indexes, *a** and *b**, varied significantly from -0.11 to -0.03 and 1.14 to 1.86, respectively. The morphology of the malanga starch is polygonal showing very irregular shapes and granules are rather small with diameters that ranged from 1 to 5 µm. At lower magnification, main differences between starch from corms and cormels were that cormels' starch appeared as big aggregates where small granules were glued to each other.

Regarding pasting performance during a heating and cooling cycle, starch from cormels had higher peak viscosity, trough, breakdown, final viscosity and setback as compared to corms' starch from the same species. The pasting properties: setback and breakdown, can be influenced by the amylose contents, since starch from cormels had higher amylose content (27.65%), leading to higher values of those pasting parameters.

In general, the starch from *Xanthosoma spp*. corms showed thermal transition at lower temperatures. The starches had low enthalpy values (corms: 16.81 and cormels: 18.82 J/g). Those values could be associated to the small granule size that reduces the length of double helices and they are disorganized with minor energy.

Therefore, significant differences were observed between the functional properties of starches from corms and cormels, which open the possibility to exploit both starches depending their physicochemical properties.

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Keywords:
Xanthosoma sagittifolium, starch, functional, thermal

Parallel Session 5.1 – Nutrition & health 1

MAKING HEALTHIER CEREAL FOODS BY APPLYING PHYSICAL TREATMENTS

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Breads have been considered staple foods in many places worldwide and in other a basic food for nutrition. Nevertheless, health is currently one of the main drivers because consumers are seeking food intake beyond nutrition. Specifically, in the case of cereal foods it is needed to explore and exploit that looking for alternatives that allow obtaining healthier breads. Simultaneously, the concept of "clean label" is somewhat dominating the market, which require a revision of food recipes. Considering both concepts, health and cleanness in labeling, the search for alternative ingredients and their physical processing offer an interesting alternative to modulate nutritional properties like starch and protein digestibility. Flours or ingredients from different sources can improve the nutritional quality of the food products, but also their physical treatment could lead to additional health improvement. Intensive milling, flour fractionation, germination and extrusion have been envisaged as very attractive alternatives to modify the glycaemic index and protein digestibility of the resulting bakery products, and even increase the amount of bioactive compounds. This presentation will give information about the impact of those alternatives in making healthy breads. Future challenges will require breakthrough innovations where health and nutrition should go hand in hand.

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Keywords:
Bread, glycaemic index, milling, extrusion

HIGH AMYLOSE WHEAT: A ROUTE TO HEALTHIER FOODS

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Dietary fibre consumption is strongly associated with better health outcomes. Epidemiological studies have consistently shown that a high intake of fibre is associated with significantly reduced risk of non-communicable diseases, including cardiometabolic and digestive disorders, and certain cancers, which are the leading cause of disability and death worldwide. Of the various food sources of dietary fibre, that from cereal grains offer significant health benefits. Cereal grains are also a major contributor to total fibre intake but population dietary surveys show that few individuals in western countries eat enough fibre. Indeed, most fall well short of the daily intake target of 25-35 g advocated by national health authorities.

Cereal foods have long been dietary pillars. They are popular, versatile and eaten frequently by most people across the age spectrum. Augmenting the fibre attributes of these dietary staples, especially those made from wheat, without compromising their consumer appeal, offers an effective means for improving diet nutritional quality thereby promoting public health.

For these reasons we developed a high amylose wheat enriched in resistant starch and total dietary fibre. The new wheat has been processed into a variety of everyday bakery items and other convenience foods. Fibre content and profile of the final products varied depending on high amylose wheat incorporation level, product type and processing conditions. Importantly, resistant starch was not seriously depleted during food manufacture and preparation, and high levels of this and other fibre constituents were present in finished products. Indeed, these foods were markedly richer in fibre than corresponding standard wheat products. High amylose wheat foods provide a practical avenue for bridging the fibre intake gap and delivering nutritional and health benefits greater than those offered by conventional wheat-based foods.

Keywords:
Amylose, Resistant Starch, Total Dietary Fibre, Wheat

RETROSPECTIVE STUDY OF STARCH DIGESTIBILITY IN CORN TORTILLA

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Starch is the main component in corn tortilla and is responsible for its functional characteristics such as texture and digestibility. Twenty years ago, a starch fraction present in foods that resisted the hydrolysis by digestive enzymes was discovered, this fraction was named resistant starch (RS). RS is not digested in the small intestine but is fermented in the colon by the microbiota which results in the production of short-chain fatty acids (SCFA) including acetic, propionic and butyric. Additional to lower glucose supply to the blood, the consumption of RS-containing foods is also beneficial given that SCFA are associated with some health benefits as colonic cancer prevention. Starchy foods as tortilla can contain RS as a result of partial gelatinization of starch and reorganization of gelatinized starch after cooling and storage. Diverse studies on starch digestibility have been reported in the last 17 years in corn tortillas, including RS quantification, hydrolysis rate and predicted glycemic index. Different corn varieties as white, yellow and pigmented maize; nixtamalization process as traditional and industrial production of corn flours and alternative nixtamalization process with salts; as well as the effect of storage, have been analyzed. RS is a fraction of total dietary fiber, so the total content of indigestible carbohydrate was included in some studies of tortillas. The effect of anthocyanins and carotenoids on starch digestibility in tortilla has been also analyzed in the last years. The importance of corn tortilla consumption in the world opened the opportunity to analyze this ancient stable food on the digestibility of its starch.

Keywords:
Resistant starch, Dietary fiber, Glycemic index, Tortilla

PURPLE WHEAT PRODUCTS: POTENTIAL ANTI-OXIDATIVE STRESS AND ANTI-INFLAMMATORY FUNCTIONAL FOODS

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Purple wheat is a colored grain containing significantly higher levels of anthocyanin pigments compared to common wheat offering an opportunity for developing healthy foods. In this study, two prototypes food products made from purple wheat, i.e. bran-enriched convenience bars and crackers, were developed as good sources of anthocyanins, phenolic acids, antioxidants and dietary fiber. The impact on postprandial plasma and urinary metabolites, inflammatory biomarkers and *in vivo* antioxidant activity were assessed. Sixteen healthy male and female participants were fed 4 servings of these products containing 6.7 mg anthocyanins and 176-213 mg phenolic acids on two separate occasions. Anthocyanins, phenolic acids, and their metabolites were quantified by HPLC and UPLC-MS in postprandial plasma and urine samples which were also analyzed for total antioxidant activity and the inflammatory biomarkers interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α). Overall, phenolic acids and their metabolites were detected in plasma and urine following consumption of the purple wheat products. However, there were no anthocyanin metabolites detected in the plasma and minimally in urine. Ferulic acid, the main phenolic acid in wheat grain, as well as hippuric acid and a few other phenolic metabolites were present in the urine within 1 h of consuming the products and up to 24 hours. The total antioxidant activity of plasma over 8 hours showed slight increases in scavenging properties within 2 and 3 hours of product consumption, but no significant differences from baseline were observed. Similarly, no changes in IL-6 or TNF-α were detected following consumption of the products. Therefore, acute consumption of purple wheat products was associated with the presence of phenolic acids in plasma and urine, but did not impact short term plasma antioxidant status or select markers of inflammation in healthy adults. Studies of longer term consumption are underway to better understand the metabolism and impacts on oxidative stress and inflammation of purple wheat based anthocyanin-enriched products.

Keywords:
Purple wheat, oxidative stress, inflammation, metabolities

PROCESSING EFFECTS ON RESISTANT STARCH FORMATION AND SHELF LIFE OF TORTILLAS

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The aim of this work was to evaluate the effect of refrigeration and palmitic acid addition on resistant starch type-3 (RS3 amylopectin retrogradation), resistant starch of amylose-lipid complexes type 5-I (RS5-I) and Type 5-II (RS5-II) and quality properties of maize tortillas during 14 days of shelf life at 4°C. Three palmitic acid concentrations (0, 1.0, 1.5%) and three storage times (0, 7, 14 days) were used on tortillas. The effect of palmitic addition on tortillas properties were evaluated by retrograded starch formation, crystallinity, pasting properties and textural changes. The temperature range and enthalpy of retrogradation of amylopectin (RS3) and resistant starch of amylose-lipid complexes type 5-I (RS5-I) and Type 5-II (RS5-II) were analyzed by DSC, obtaining a retrogradation reduction in comparison with tortillas elaborated without palmitic acid. Addition of palmitic acid (1.0, 1.5%) in tortillas showed an unexpected increment of RS5-I and RS5-II at 7 and 15 days of refrigeration at 4°C. The thermal properties of RS5-I and RS5-II at low temperature suggest a new mechanism of formation of those complexes different than annealing, in this case was a re-crystallization similar to retrogradation that increases melting enthalpies of RS5-I and RS5-II. The increased amylose-lipid complexes were confirmed by additional peak viscosity during pasting and x-ray diffraction with a peak at $2\theta \approx 17.0°$ compared to low intensity peak from samples without PA that did not form amylose-lipid complexes. At 7 days of storage retrogradation was 72.0, 19.0 and 9.0% for amylopectin, RS5-I and RS5-II respectively. Texture evaluation suggests that retrogradation reduction, influences directly tortilla texture ($r=0.82$; $p < 0.007$). Chemical changes in tortillas by palmitic acid have a positive impact in the healt and final quality of these product.

Keywords:
Amylose-lipid complex, Amylopectin, resistant starch, retrogradation

Parallel Session 5.2 – Durum wheat & pasta

INDUSTRIAL QUALITY ATTRIBUTES OF GLOBALLY DISTRIBUTED CIMMYT DURUM WHEAT GERMPLASM: HISTORICAL EVOLUTION, RECENT GENETIC IMPROVEMENT STRATEGY AND CURRENT STATUS

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The durum wheat germplasm distributed globally by CIMMYT is the primary source of cultivars for developing countries and a highly valuable source of improved crossing parents for breeding programs worldwide. Results from a two-years study under controlled, fully irrigated conditions of all lines (N=945) globally distributed from 1969 to 2011, indicated that while grain yield continuously increased over the years, grain protein content did not keep decreasing after the 90s in any substantial fashion, as it would be expected. This suggested that the progress in yield potential was accompanied by a proportional increase in the capacity of the germplasm to uptake nitrogen and⁄or translocate it into the grain. Gluten strength was fixed at acceptable to high levels early on upon the close to complete elimination, in the late 1980s, of the weak gluten types (Low Molecular Weight Glutenin type 1). High pigment lines were always present in the outgoing germplasm and their frequency was variable over the years. In light of these results and of our assessment of the needs of breeding programs worldwide, CIMMYT implemented a genetic improvement strategy which included the most important and highly inheritable quality traits as primary breeding targets. Axes of this strategy include the maintenance of a high frequency of lines with high grain size and no defects in its physical characteristics, the systematic elimination of weak gluten types and a very strong emphasis on increasing the frequency of lines with acceptable to outstanding grain yellow color. The success of this strategy will be demonstrated through the presentation of results showing the continuous improvement of important quality attributes in the most recently distributed groups of germplasm.

Keywords:
durum wheat; breeding; genetic gains; grain quality

GLUTOPEAK: A BREEDING TOOL FOR SCREENING DOUGH PROPERTIES OF DURUM WHEAT

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A rapid shear-based test using a GlutoPeak instrument was compared with tests commonly used by durum wheat breeders to assess the potential of this instrument to discriminate between dough quality. Various sample sets were used: one with a wide diversity in genetic background and a validation set consisting of breeder's advanced lines to select for dough strength based on GlutoPeak mixing time data. The reproducibility of the test using semolina and wholemeal were compared. GlutoPeak peak maximum time (PMT) was the best indicator of gluten strength and correlated well with the other tests like mixograph resistance breakdown, peak mixing time, gluten index but not SDSS. The categorization of samples in the validation set by GlutoPeak was compared with data from mixograph and gluten index to evaluate the effectiveness of GlutoPeak as an early generation breeding tool. The GlutoPeak test is faster than other tests and uses less sample, works better with wholemeal than semolina and requires little technical skill, and so is suitable for evaluating large numbers of breeder's lines. The GlutoPeak test was also compared with a range of other early generation tests to predict protein quality such as SIG, SE-HPLC unextractable polymeric protein (UPP) and turbidity (IP). While UPP and IP were highly correlated, Glutopeak PMT was a better predictor of dough strength and is quicker and cheaper to perform once the equipment is acquired.

Keywords:
dough, durum wheat, GlutoPeak, screening

EVALUATION OF IMPORTANT QUALITY PARAMETERS FOR PASTA INDUSTRY ON SOME DURUM WHEAT LANDRACES GENOTYPES IN TURKEY

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Wheat is grown in almost all regions, but especially in Central Anatolia region of Turkey is the most important cultivation areas. In addition to this, Turkey is known as a major center of wheat and barley variety. In particular, durum wheat has a significant genetic diversity in the east of Anatolia and has spread to other countries from Anatolia. Using the genetic diversity of durum wheat will be effective in the development of new varieties. In particular, the increase in global warming will increase the importance of biotic and abiotic stress tolerant varieties. Local varieties need to be used in breeding programs to ensure food safety and sustainability in a possible global warming in the future.

The aim of this study was to determine the quality of genotypes which were selected from local durum wheat populations obtained from Turkish seed gene banks in Turkey. For this purpose, 100 genotypes were determined according to weight, diameter, hardness, glassy grain ratio, protein ratio, moisture ratio, and ash content on the grain under the methods of ICC 2008. This samples were milled in Brabender junior mill and flour color (L, a, b), SDS sedimentation, modified SDS sedimentation, wet gluten content, dry gluten content, stretching and relaxation time analyses were done.

Grain weight, diameter, hardness, glassy grain, protein, moisture and ash content of the samples change between 37.07 - 61.9 mg, 2.6 - 3.4 mm, 61.9 - 97.3%, 93-100%, 12.25-20.9%, 6.6-9%, 1.25-2.2% respectively. The SDS sedimentation, modified SDS sedimentation, wet gluten content, dry gluten content, gluten Index, stretching (BU), stretching time (s), relaxation and L, a, b values of the samples are in the range of 8 - 62 ml, 11 - 68 ml, 12.3-52.1%, 4.1-17.3%, 1.0-79, 413 - 934 BU, 1-125 s, 360 - 916 BU, 83.5 - 97.7%, 1.62 - 3.8%, 15.03 - 22.5% respectively.

Seven lines exceeded the value of 41 ml in SDS Sedimentation analysis, 17 samples with a strong gluten structure showed a higher b value than 20% and 16 samples have a gluten index value more than 50%. All these parameters are essential and important for the pasta sector.

Keywords:
Durum wheat landraces, pasta quality, gluten

AN INTEGRATED APPROACH TO INVESTIGATE THE FUNCTIONING OF WHEAT QUALITY COMPONENTS AND THEIR INTERACTION WITH ENVIRONMENT

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The aggregative properties of wheat grain prolamins are largely responsible for the technological functionalities of the flours and semolina that will be extracted from bread-wheat and durum wheat, respectively. Indeed, the ability of wheat prolamins to form a plastic three-dimensional network during the mixing depends to a large extent on their ability to interact. These aggregative properties, which can be evaluated today by measuring their molecular weight distribution, is dependent on the polymorphism of the protein subunits present but also, to the environmental conditions that are applied during the grain development. Indeed, any modification of the redox status of the grain tissues in response to an oxidative stress can lead to a decrease in the degree of association of the prolamins by limiting the protein-protein interactions during the grain desiccation. Considering the current and future environmental imperatives (i.e. climate changes with increasing heat stress), it is essential to better understand these phenomena to implement new breeding strategies for a sustainable quality. For this purpose, an integrated approach allowing to investigate wheat components variation with Environments (E), Genotypes (G) and EXG is adopted. Researches on durum wheat *(Triticum durum* L.) with Tunisian (local and high yielding) varieties and on bread wheat (*Triticum aestivum* L.*)* with diverse French varieties, were carried out, through the collaboration between National Agronomic Institute of Tunisia-INAT and Polytechnic Institute Uni-Lasalle-Beauvais. Where, our main directions and activities are to investigate genotypes and evaluate the stability of their quality in different environments. Molecular identification, quantification and distribution were assessed for prolamins and starch components using EC-Lab-on-CHIP, HPLC, Asymetric Field Flow Fractionation, Spectroscopy. Our researches showed that it is very important to consider, in the improvement of wheat quality, the best behavior genotypes and their performance under poor environments; and explore potentialities by investigating relationships between agronomical, biochemical and technological parameters. On the basis of these relationships further investigations on end-products could contribute to the effectiveness of this integrated approach.

Keywords:
Quality, wheat, prolamins, molecular distribution

Parallel Session 6.1 – Whole grains (organized by HGF)

GRAINS AND WHOLE GRAINS: JUST FOR THE HEALTH OF IT

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Whole grain foods have been shown in epidemiological studies from around the world to be associated with lower weight gain over time and reduced risks of chronic and other diseases. Decreased mortality rates have also been associated with the intake of at least 50 g or more of whole grains. Findings show that the right balance of whole and refined grains are key in terms of associations with the lowest visceral adipose tissue and other endpoints. This talk will discuss recent meta-analyses and systematic reviews showing the strength of the evidence, which despite non-uniform definitions⁄ standards for whole grain foods shows consistency across studies. Some report whole grains in servings, others grams of whole grains, and some use different percentages of whole grain in a product to determine what is a whole-grain food. While most studies, show that ingestion of whole grains is associated with lower risks, a number of studies do not show an increase in health risks when enriched, refined grains, especially those from staple foods are eaten in the recommended amount and balance.

Whole grain consumers are associated with better health outcomes in nearly all epidemiological studies, but such consistency is lacking in intervention trials. Reasons for these discrepancies such as a population sample size too small or diverse or not at risk for disease or length of the study too short will be discussed.

Epidemiological studies also have confounding and may have an unintended bias. Whole grain eaters tend to have better overall diets and health habits than non-whole grain consumers, attributing the health benefits specifically to whole grains difficult. Many food surveys were conducted when nearly all whole grain foods were staples (e.g. bread and brown rice). Few, if any, indulgent foods were made with whole grains. So health benefits attributed to whole grain foods may be due ingestion of recommended staple grains rather then frequent consumption of refined grain snacks and desserts. The latter may add calories, sugar, saturated fat and salt, and bare nutrient poor choices potentially displacing other recommended foods.

Associations between reduced chronic disease risks and intake of whole grains are based primarily on processed grain-based foods from the marketplace. Some public health professionals advocate the NOVA system, which suggests consumers eat mostly minimally processed foods (MPF) and eschew processed food (PF) and ultra processed food (UPF). This system categorizes all breads and most all grain-based foods as PFs or UPFs. The reality is that grain MPFs such as oatmeal, brown rice and whole kernels contribute only a small portion of the total whole grain intake, so positive health benefits and reduced disease risk in epidemiological studies are associated with whole-grain PFs and UPFs. In summary, the positive health effects of at least 50 g of whole grains may be a direct effect or may be indicative of those who adhere to dietary and health advice or a synergy of both. The overall evidence shows

that the right balance of whole and enriched refined grains yields higher diet quality, more fiber, nutrients and phytochemicals and is associated with lower disease risk, so consumers should choose grains 'just for the health of it.'

Keywords:
"health and wholegrains" 'processed whole grains" "right balance of whole grains" "whole grain staples"

DEFINITIONS FOR WHOLE GRAIN AND WHOLE GRAIN FOODS – PERSPECTIVES FOR GLOBAL HARMONISATION

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The Whole Grain Declaration, issued by the 6th Whole Grain Summit, Vienna, November 2017 states as 1st key goal: " *Reach consensus on a global definition of a whole grain (raw materials) and on the definition of a whole grain food"* with as action points: *"Convene a global working group including key grain science groups and experts from diverse regions, to finalize a definition of whole grain (raw materials) using the Healthgrain Forum (HGF) definition as a starting point"* and: *"Follow a similar process for defining a whole grain food, once a global intake recommendation has been agreed".* International harmonization of definitions will contribute to clarity for consumers, effective communication, facilitation of international trade and, in Europe, to approval of health claims.

Definitions for WG as raw material generally agree about the basic principle: *"Whole grains shall consist of the intact, ground, cracked or flaked kernel after the removal of inedible parts such as the hull and husk. The principal anatomical components, the starchy endo-sperm, germ and bran, are present in the same relative proportions as they exist in the intact kernel".*

Whole grain foods are less widely defined and major differences exist. For bread, the most widely defined WG food, 100% of the flour (UK, Netherlands), > 90% (Germany) or > 50% (Scandinavia) should be whole. The Oldways Whole Grains Council is using stamps for 3 level labelling 100%, 50%, some. Due to launches of a wide range of WG products - breakfast cereals, bakery products, porridges, soups, snacks - the need was felt for setting a general minimum WG (flour) level for labelling a product as WG

HGF is aiming in its definitions at facilitating a high intake of the nutrients and other bioactive compounds of WG and at not creating barriers. For WG as raw material HGF (2010) adopted principles of the widely used AACCI definition (1999) such as the inclusion of pseudo-cereals. HGF also included two widely applied practices: 1) removal during milling of max. 2% of the grain for quality and safety reasons (the outer bran layer may contain relatively high levels of contaminants) and 2) recombination of endosperm, germ and bran in the correct proportions both by flour millers and others, such as producers of consumer products. For calling a food a WG food HGF required the presence of more WG than refined flour and ≥ 30% WG flour on a dry-weight basis. Allowing the presence of refined flour may have contributed to the major increase of WG consumption in the Danish WG campaign, by reducing a 'taste barrier'.

For developing and implementing global WG definitions a wide range of issues can be considered such as a) Publication as a definition in the CODEX system, as an ISO standard, or just as a Declaration? b) Harmonization of global and national definitions – is the system used for European Union Directives an option: a definition at the member state level can be equal or more strict than the EU definition? c) When do we prefer 'open' or 'closed' formulations?

Example: ‘processes such as A, B, and C are allowed’ or ‘processes A, B and C are allowed’. d) The HGF WG definition requires Good Manufactures Practices; should also practical system for quality control be recommended or required? These and other issues will be addressed in the recently formed global working group. LACC4 attendants - you can contribute at LACC4 by sharing your views

For more information http://healthgrain.org/whole-grain/

Keywords:
Whole Grain Definitions, Global harmonisation

A GLOBAL MOVEMENT TO INCREASE WHOLE GRAIN INTAKE – PLANS AND ACTIONS

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Cereals are one of the most important food sources worldwide. This has led to a lot of investment and rapid developments in the field of food technology and processing and the marketing of many refined flour products that contain lower levels fiber micro-nutrients, anti-oxidants and other beneficial compounds.

For over three decades, repeated studies have clearly demonstrated that people eating more whole grains have reduced risks of many diseases compared to those eating less. New data on the links between diet and health show that replacing refined grains with whole grains globally could reduce the burden of chronic disease more than any other change – including better-known approaches such as reducing sodium, eliminating trans fats or even cutting sugar-sweetened beverages. This has led many countries to adopt specific recommendations for people to choose whole grain-based foods instead of refined grain-based foods. Yet current data suggest that whole grain intake in most countries has not increased markedly and remains well below recommended levels, which is a concern for long-term public health.

To increase whole grain intake, efforts cannot be limited to one or two stakeholders, and must be addressed using the combined efforts of all parties involved in the food supply chain. For this reason, more than 200 renowned experts and leading stakeholders, representing more than 35 countries, came together at the 6th International Whole Grain Summit, 13-15 November 2017 in Vienna, Austria, organised by the International Association for Cereal Science and Technology (ICC), with the common goal of creating a collective action plan to increase whole grain intake worldwide, for the health and well-being of all people.

To make this happen, ICC together with international experts formulated a Whole Grain Declaration (http://www.icc.or.at/wholegraindeclaration) and an action plan that will address strategies to help promote healthy eating patterns, particularly an increased variety of whole grain foods including the ancient grains, and additionally communication-promotion campaigns based on strong public private partnerships. Interactions with the WHO - World Health Organisation, FAO - Food and Agriculture Organization of the United Nations, EFSA - European Food Safety Agency and national food authorities will be part of the action plan, which shall be presented with this presentation.

Keywords:
ICC, Whole Grains, Health, Sustainibility

MAKING WHOLE GRAINS THE NEW NORM: CHANGING CONSUMER ATTITUDES AND PERCEPTIONS IN LATIN AMERICA AND AROUND THE WORLD

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Decades of scientific studies and nutrition research have clearly demonstrated the link between increased whole grain consumption and reduced risk of many diseases. But, despite overwhelming evidence that we should be eating more whole grains, populations around the world struggle to meet recommended levels of intake. Since its founding in 2003, the Oldways Whole Grains Council has partnered with health professionals, food manufacturers and researchers globally to educate consumers about the health benefits of whole grains and to help food companies create more, and better, whole grain products. Our experience tells us that the barriers to whole grain consumption turn out to be very similar around the world, in wealthy countries as well as in developing ones.

This session will identify some of these consumer-perception challenges before turning to focus on several models of success for changing consumer attitudes. We will present data taken from our own WGC Stamped Product Database demonstrating that whole grain momentum is already building in Latin America, and we will explore the ways in which the goals of the 2017 Whole Grain Summit in Vienna can be turned into action in this region. We'll conclude by using whole grain success stories to outline key takeaway lessons and discuss strategies for increasing whole grain consumption that *any* community can implement, no matter where its people fall on the continuum of whole grain acceptance.

Keywords:
consumer attitudes, increasing whole grain consumption, health benefits of whole grains, communication strategies

ATTITUDES TO WHOLE GRAIN FOODS, THEIR BENEFITS AND LIKING: INSIGHTS FROM CONSUMERS IN MEXICO, COLOMBIA AND A GLOBAL PERSPECTIVE

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There is significant confusion among consumers across the globe about how much whole grain should be consumed daily, while consumers' acknowledge wholegrain as something important, a significant part of the people surveyed does not know how much wholegrains they should consume each day, where to find it and are not clear on the benefits of increasing wholegrain dietary intake.

The lecture will cover the results of a new study of over 16,000 people across the globe commissioned by Cereal Partners Worldwide, the producer of Nestlé Breakfast Cereals, and conducted online by independent research company Censuswide in October, 2017. It surveyed 16,173 adult consumers in 11 countries including: Colombia, Mexico, Denmark, Finland, Norway, Sweden, Kingdom of Saudi Arabia, United Arab Emirates, Malaysia, Turkey, and the United Kingdom. The lecture will focus particularly in the results for Mexico, Colombia and compared to the global results.

This research shows that people need help knowing how much whole grain to eat and importantly why getting more whole grain in our diets matters. The World Health Organization recommends an increase in whole grain consumption along with increases in fruits, vegetables, legumes and nuts for the prevention of chronic disease.Higher consumption of whole grain has been associated with a reduced risk of heart disease, obesity, type-2 diabetes and bowel cancer.

Despite the benefits, only three countries – the USA, Netherlands and Denmark – have a quantitative recommendation for whole grain. Denmark has seen a 72% increase in whole grain intake, following the introduction of guidelines alongside a government-backed campaign.

There is an opportunity for governments, academics and industry to back a global commitment to help inform people about whole grain and to increase the availability of whole grain foods. The first step on this journey is to agree to a set of global guidelines for recommended daily whole grain intake.

Keywords:
Wholegrain, consumer, understanding

Parallel Session 6.2 – Food legumes

THE USE OF NITROGEN GAS AS A PHYSICAL BLOWING AGENT TO PRODUCE PUFFED SNACKS MADE FROM YELLOW PEA FLOUR

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Extrusion is a high throughput process with the flexibility to control food design, to load plant protein-rich ingredients into foods, and an effective means of engineering bubbles into foods. Extrusion converts dense, hard materials into lighter, more palatable and appealing forms, significantly enhancing food quality. In this study, our objectives were to manipulate the physical, textural and microstructural properties of extrudates made from yellow pea flour (~20%) using gas (nitrogen) assisted extrusion. To the best of authors' knowledge, the effect of nitrogen gas injection on physical, textural and microstructural properties of yellow pea extrudates has not been reported previously. Extrudates were prepared at three different feed moisture contents [low (14%), medium (16%) and high (18%)] and nitrogen gas (3 bar) was injected into the extruder barrel as a physical blowing agent. Extrusion was performed using a lab-scale, co-rotating twin screw extruder equipped with a circular die of 2.3 mm diameter, at constant screw speed of 200 rpm and die temperature of 150 °C. The changes in extrudate bulk density, expansion index, textural properties (hardness, crunchiness, crispiness and bowl life) and microstructure (as measured by SEM) were feed moisture content dependent. In addition, the injection of nitrogen gas into the extruder barrel resulted in extrudates with more homogeneous microstructures while at the same time affecting extrudate physical and textural attributes. These results showed that extrudate density, expansion index and textural properties can be manipulated using physical blowing agents such as nitrogen to enable production of extrudates with a spectrum of aerated structures, especially at higher moisture contents where extrudate physical quality is often impaired.

Keywords:
extrusion, physical blowing agent, yellow pea flour, physical properties

NIXTAMALIZATION AS AN ALTERNATIVE FOR BEANS (*Phaseolus vulgaris* L.) PROCESSING

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Nixtamalization is an excellent process for Ca fortification of staple corn-based foods. In this work, three nixtamalization processes: classic using wood ashes, traditional with $Ca(OH)_2$, and ecological with $CaCl_2$, were used for processing black beans into flours. One kg of beans was cooked 2 h⁄94 °C in a water-calcium source solution at 1.5% (w⁄w). Cooked beans were dried in a flash dryed at 250 °C⁄16 s, milled and sieved trough a 0.5 mm mesh. Bean flours were characterized for their chemical composition, starch digestibility, mineral profile, as well as by DSC, X-ray diffraction, FT-IR. Nixtamalization increased the Ca content of bean flours 2.02-6.4-fold (278.93-886.51 mg⁄100 g) respect to raw beans (137.77 mg⁄100 g). Classic process increased the Fe content > 82.0%. Raw beans had C-type starch, 10.10% resistant starch, and two DSC endotherms: 1) starch gelatinization and 2) melting of amylose-lipid complexes plus protein denaturation. Nixtamalization decreased the RS content to 4.19-4.43%, and produced starch retrogradation. DSC and FT-IR analysis of flours evidenced the denaturation of bean proteins, decreasing the second transition enthalpy and absortion bands of amide I, II and III. Processing of beans into flours by traditional and classic nixtamalization is an alternative for mineral fortification of flours which could be used as ingredients in the elaboration of tortillas, breads or snacks with a good nutritional profile. The nixtamalization is an excellent process for Ca fortification of staple corn-based foods. In this work, three nixtamalization processes: classic using wood ashes, traditional with $Ca(OH)_2$, and ecological with $CaCl_2$, were used for processing black beans into flours. One kg of beans was cooked 2 h⁄94 °C in a water-calcium source solution at 1.5% (w⁄w). Cooked beans were dried in a flash dryed at 250 °C⁄16 s, milled and sieved trough a 0.5 mm mesh. Bean flours were characterized for their chemical composition, starch digestibility, mineral profile, as well as by DSC, X-ray diffraction, FT-IR. Nixtamalization increased the Ca content of bean flours 2.02-6.4-fold (278.93-886.51 mg⁄100 g) respect to raw beans (137.77 mg⁄100 g). Classic process increased the Fe content > 82.0%. Raw beans had C-type starch, 10.10% resistant starch, and two DSC endotherms: 1) starch gelatinization and 2) melting of amylose-lipid complexes plus protein denaturation. Nixtamalization decreased the RS content to 4.19-4.43%, and produced starch retrogradation. DSC and FT-IR analysis of flours evidenced the denaturation of bean proteins, decreasing the second transition enthalpy and absortion bands of amide I, II and III. Processing of beans into flours by traditional and classic nixtamalization is an alternative for mineral fortification of flours which could be used as ingredients in the elaboration of tortillas, breads or snacks with a good nutritional profile.

Keywords:
Bean flours, calcium fortification, bean starch properties, beans nixtamalization

DISCOVERY OF UNIQUE LOW RESISTANT STARCH DRY BEAN (*Phaseolus vulgaris* L.) GENOTYPES

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Dry beans (*Phaseolus vulgaris* L.) are a nutrient dense food and are enriched in protein, minerals and complex carbohydrates. Beans are made up of approximately 54% carbohydrates, where most of the carbohydrate is stored in the form of starch. From a nutritional and health perspective the carbohydrate fraction, especially resistant starch, of beans are of particular interest. Resistant starch is the starch that is not converted to glucose in the gut, but is fermented in the colon and is considered a component of dietary fiber. In this study, the resistant starch contents of four bean genotypes were explored; Canario and Cebo Cela (yellow beans), Alpena (navy bean) and Samurai (otebo bean). Results indicate that the resistant starch content for milled uncooked Cebo Cela flour was 12 times lower (3% vs 35%) than its counterpart Canario. Similiarly, Samurai yielded significantly lower RS levels (8%) than Alpena (38%). In general, the resistant starch content in raw beans ranges from 26 to 39% and both Cebo Cela and Samurai fall outside of that range. The factors or mechanisms that contribute to the low resistant starch contents include particle size distribution, gelatinization parameters and alpha amylase inhibitors in the bean flour or starch. It remains to be determined how widespread the low resistant starch characteristic is among dry bean germplasm. This low resistant starch trait will have implications for flour milling and end use applications.

Keywords:
Dry beans, Starch, Resistant starch, Particle size distribution

Parallel Session 7.1 – Food safety

MYCOTOXINS AND HEALTH

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Deoxynivalenol (DON) is a mycotoxin that is produced when wheat and other cereal grains are infected with *Fusarium* spp. Mycotoxins are some of the most abundant naturally occurring toxins in human diets. DON is one of the most commonly occurring mycotoxins and presents a serious health risk. In addition to the presence of DON, plants infected with *Fusarium* may produce masked mycotoxins, such as deoxynivalenol-3-β-d-glucopyranoside (D3G). D3G is a plant metabolite produced as part of a detoxification process. There has been some emerging interest in the fate of D3G and other masked mycotoxins in the gut and their contribution to toxicity. D3G has been determined to have lower absorption and toxicity than DON. D3G was found to have two to five times lower oral bioavailability than DON and was found to be unable to sterically bind to the target for DON induced ribosomal toxicity. Some studies have shown that D3G is stable in the stomach and small intestine. However, D3G can be hydrolyzed by fecal microbiota and be further metabolized to De-epoxy DON (DOM-1). An *in vivo* study determined that one hundred percent of D3G was hydrolyzed by fecal microbiota after six hours. The release of DON from D3G by the fecal microbiota can increase the toxic load for exposed individuals. For this reason, it is important that a comprehensive understanding of the fate of DON, D3G and other mycotoxins and masked mycotoxins in the human body be investigated. Since the presence of multiple mycotoxins may be occurring in the human diet, additional study of the synergistic and additive effects and risks of all mycotoxins in foods will be crucial.

Keywords:
mycotoxin, Deoxynivalenol (DON) , deoxynivalenol-3-β-d-glucopyranoside (D3G), wheat

FATE OF DEOXYNIVALENOL AND DEOXYNIVALENOL-3-B-D-GLUCOPYRANOSIDE DURING WHEAT PROCESSING

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Deoxynivalenol (DON) is a mycotoxin which can be produced in cereal grains infected by Fusarium Head Blight (FHB). DON is a very stable compound, during storage, milling, processing and cooking of food. The plant may transform DON by conjugation of the respective mycotoxin to functional groups or molecules. Conjugation of DON with glucose results in Deoxynivalenol-3-β-D-glucopyranoside (D3G), the main DON metabolite in wheat. The objective of this research was to identify the fate of D3G and DON during wheat processing. DON was measured using GC-ECD and D3G was measured using LC – MS⁄MS during milling and baking of hard red spring wheat. DON was also determined in whole wheat after treatment with several enzymes. After removal of bran by milling, there was an approximate reduction of 61.8% and 23.7% in the DON and D3G contents, respectively. DON levels detected during fermentation (3.03 to 3.93 µg⁄kg) were significantly higher ($P < 0.05$) than in mixed dough (1.97 µg⁄kg). There were no significant differences ($P < 0.05$) in the D3G in the dough samples. However, the baked bread had significantly ($P < 0.05$) less D3G detected than the dough. There were significant differences ($P < 0.05$) between the wheat treated with α-amylase, cellulase, protease, and xylanase. DON levels were significantly ($P < 0.05$) higher after treatment with protease (16%) and xylanase (39%) compared to the wheat composite. These results suggest that DON may be bound to the cell wall matrix or protein component of the wheat kernel, due to the rise in detection of DON after these enzyme treatments. Overall, processing or enzymes present in wheat or wheat products may result in release of DON and an increase of DON content in food products.

Keywords:
Mycotoxins, Deoxynivalenol, Deoxynivalenol-3-β-D-glucopyranoside, wheat processing

FATE OF DEOXYNIVALENOL DURING WET MILLING PROCESS

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The fungal disease *Fusarium* Head Blight (FHB) affects cereal grains, and is able to produce mycotoxins like deoxynivalenol (DON). The occurrence of DON in harvested grain results in health concerns for both human and animal wellbeing. The mycotoxin can be found in the outer and inner layers of the kernel, making latent the risk of contamination of cereal-based products. The fate of DON during wheat farina⁄semolina fractionation by wet milling technique was investigated. Hard red spring wheat (HRSW) and Durum wheat samples contaminated with DON were collected from an annual 2016 crop survey and were milled into farina and semolina, respectively, shorts, and bran. Determination of DON levels on each dry milled fraction was performed by Gas Chromatography with Electron Capture Detection (GC-ECD). Subsequently, the dry milled fractions underwent a bench-scale wet milling process, by consecutive gluten washing steps, as well as the centrifugation of the obtained starch rich fraction. Gluten and starch fractions were dried overnight at 45°C in a convection air oven. In addition, the residual water from the washings was combined and freeze-dried. DON concentration was determined on each fraction by GC-ECD. The results obtained showed that DON was present in the three dry milled fractions, with bran having the highest concentration. DON concentration in farina and semolina exceeded the security threshold for human consumption. After wet-milling, DON was not detected in the gluten or starch fractions but was detected in the wash water. The study confirmed that DON decreases to undetectable levels after the wet milling process, arising as a novel technique for giving some added value to contaminated grain.

Keywords:
Deoxynivalenol, Food safety, Mycotoxin, Wet-milling

MY TOOLBOX – SAFE FOOD AND FEED THROUGH AN INTEGRATED TOOLBOX FOR MYCOTOXIN MANAGEMENT

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The MyToolBox consortium led by Rudolf Krska (BOKU/IFA-Tulln) will not only pursue a field-to-fork approach along the food and feed chain, but will also consider safe use options of mycotoxin contaminated batches such as microbial energy conversion to efficiently produce biogas and bioethanol assisted by novel enzymes. Intervention technologies considered within MyToolBox include the investigation of genetic resistance to fungal infection, cultural control, the use of novel biopesticides, competitive biocontrol treatment and the development of new forecasting approaches to predict mycotoxin contamination. Research into post-harvest measures includes real-time monitoring during storage e.g. in China, innovative sorting of crops using vision-technology and novel down-stream processing approaches such as innovative (pre-) milling technology. Research into the effects of baking on mycotoxin levels will provide a better understanding of process factors used in mycotoxin risk assessment. The mycotoxin commodity combinations that will be addressed are the most prevalent *Fusarium* mycotoxins (DON, T-2/HT-2 toxins, ZEN and fumonisins) in wheat, oats, maize and animal feed chains, ochratoxin A in wheat and aflatoxins in maize, peanuts and dried fruit (figs). The developed measures will be combined with existing knowledge and will become accessible via a dynamic web-based MyToolBox e-platform. MyToolBox mobilises a comprehensive multi-actor approach with 23 partners with > 40% industry participation including 5 end users from the farming community, agronomists and professionals working in agriculture and food manufacturing.

Keywords:
MyToolBox, mycotoxin management, safe food

AFLATOXIN MANAGEMENT FOR THE CARIBBEAN REGION: PROSPECTS FOR BIOLOGICAL CONTROL

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Aflatoxins are genotoxins that cause cancer, impair immune systems, retard human development, reduce animal productivity, and prevent access to premium markets.

Crop contamination with aflatoxins is caused by several *Aspergillus* species that are distributed in plants, insects, soil, and air throughout warm regions including the Caribbean Region. Aflatoxin formation begins during crop development and continues through crop maturation, harvest, and storage. Crops remain vulnerable until consumed. Human exposure occurs either upon consumption of contaminated crops and products of animals fed contaminated crops or when small crop fragments and fungal spores are respired. A simple biological control alters fungal populations so that aflatoxin producers are scarce and the quantities of aflatoxins in crops, and throughout the environment, are reduced to below levels of concern. Biocontrol products that use atoxigenic genotypes of *A. flavus* as active ingredients have been effective on millions of hectares of maize, groundnut, pistachio, fig, and cottonseed across many countries around the world. Large-scale commercial use of this type of biocontrol in the developed world has shown the safety of fungal communities improving both on treated crops and throughout production areas. Atoxigenic biocontrol products utilizing atoxigenic genotypes of *A. flavus* as active ingredients are also produced in developing countries and are a simple, low tech method for improving both human health and access of agricultural products to markets. Applications take advantage of natural fluctuations in magnitude and composition of fungal communities with treatment influences extending across areas and between seasons with cumulative benefit. Over the past two years efforts have been initiated towards to the selection of endemic well adapted atoxigenic genotypes of *A. flavus* for biological control products developed for use in the Caribbean Region.

Keywords:
Biological Control, Maize, Aflatoxin Prevention, Mycotoxins

ANALYSIS OF DEOXYNIVALENOL AND DEOXYNIVALENOL-3-GLUCOSIDE IN HARD RED SPRING WHEAT INOCULATED WITH FUSARIUM GRAMINEARUM

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Almost every agricultural crop, including wheat, can be infected by fungi during plant growth and⁄or after harvest. *Fusarium graminearum* is one example of a fungus that is prevalent pathogen in wheat. Mycotoxins, such as *Fusarium graminearum*, pose a serious health risk to humans and animals. Deoxynivalenol (DON) is a trichothecene mycotoxin produced by *Fusarium* spp. The formation of the "masked" mycotoxin deoxinyvalenol-3-glucoside (D3G) results from a defense mechanism the plant uses for detoxification. The aim of this work was to analyze DON and D3G content in inoculated near-isogenic wheat lines grown at two locations in Minnesota, USA during three different years. DON and D3G were measured using UPLC with HRMS. DON content ranged from 0.0 to 39.5 mg⁄kg, while D3G content ranged from 0.0 to 3.8 mg⁄kg. The D3G content rose following a linear trend as the DON content increased in samples with DON content between 0 and 30 ppm. However, at higher DON concentration, a decrease in the D3G content was seen. ANOVA demonstrated that the line and location have a greater effect on variation of DON and D3G than do their interaction among years. The results of this study on D3G could help to increase the data about its occurrence in hard red spring wheat in the USA. There is not currently as statement in the USA on the maximum levels of D3G in food and feed, due to lack of data about this masked mycotoxin. The most important factor affecting DON and D3G was the growing location. In conclusion, the year, environmental conditions and location have an effect on the D3G⁄DON ratio in response to *Fusarium* infection. Also, tolerance of the wheat lines to the Fusarium infection is related to the ability of the wheat line to convert the DON to D3G during the detoxification process.

Keywords:
fusarium; wheat; deoxinyvalenol; deoxynivalenol-3-glucoside

Parallel Session 7.2 –Nutrition & health 2: Dedicated to Prof. Radomir Lásztity

NOVEL PHENOTYPING TOOLS TO ASSESS GLYCAEMIC POTENTIAL OF RICE GERMPLASM

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Diabetes and related non-communicable diseases are becoming epidemic in Asia. Rice lines with slower digestibility provide novel opportunities for diet based intervention to counter the growing problems. However, screening for low glycemic 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.

Keywords:
rice, glycaemic index, starch, amylose

WHEAT BRAN MODIFIED BY AUTOCLAVING HAS REMARKABLE PROPERTIES THAT SUGGEST SIGNIFICANTLY ENHANCED HEALTH BENEFITS

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This presentation reviews results of a now concluded research project on the remarkable transformation of properties of wheat bran when subjected to routine autoclave conditions. The modified wheat bran (MWB) lacked the strong and distinct sensory attributes of traditional bran, having a mild aroma and flavour that carried into bread. Most noteworthy were the chemical and functional food-related properties of MWB. In particular, antioxidant activities of water extracts were enhanced by more than 300% compared to extracts from unprocessed wheat bran. Extractability and⁄or solubility of phenolic acids, arabinoxylan, β-glucan, resistant oligosaccharides, B-vitamins and some minerals which are very limited in traditional wheat bran were substantially increased in MWB. Results of cell and animal model studies reflect a compelling range of important bioactivities for both MWB and extracts. Using a hypercholesterolemic hamster model, MWB consumption at 10% addition by weight in the diet was associated with increased metabolic rate, increased lean mass, lower fat mass and lower blood glucose. MWB extracts assessed *in vitro* showed significant inhibition of selected cancer cell growth, reduced LDL oxidation and significant increase in mouse macrophage cell proliferation suggesting immune enhancing properties. Results as a whole indicated that the nutritional and health benefits normally ascribed to traditional wheat bran likely represent a fraction of its potential. Wheat bran modified by autoclaving appears to have considerable value for whole grain food and health products far beyond what may be possible with traditional wheat bran.

Keywords:
wheat bran, processed wheat bran, antioxidants, fibre

TOWARDS THE DEVELOPMENT OF A NEW GLUTEN REFERENCE MATERIAL

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An important factor to assess the safety of gluten-free food is the reliable and accurate quantitation of gluten. Currently, the most frequently applied methods in routine gluten analysis are enzyme-linked immunosorbent assays (ELISA), but other analytical methods, such as liquid chromatography-mass spectrometry and PCR are also used and⁄or under development. The improvement of analytical performance of these methods is affected by many factors, such as genetics x environment effects on protein composition, different target proteins and epitopes, denaturation of macromolecules during food processing, etc. From the viewpoints of validation of analytical procedures, comparison of results obtained with different methods and improving the accuracy of results, the lack of reference materials (RM) is the key limiting factor. In gluten RM development, the general questions are the following: 1) Format: Is it preferable to use isolated protein fractions or row materials (i.e. wheat flour)? 2) Stability: How can long-term stability be ensured? 3) Representativeness and commutability: Should a single cultivar or a mixture of selected cultivars be used? 4) Selection criteria: How can the most representative cultivars be selected for RM production? In our work, grains of wheat cultivars from different geographical origins and countries were collected and characterized for chemical composition, gluten content and protein composition determined by size-exclusion and reversed-phase high performance liquid chromatography as well as by electrophoretic methods. Finally, the selection criteria for representative wheat cultivars were defined and five wheat cultivars were selected. These cultivars were investigated further in different harvest years and two RM candidates (from a single cultivar and a blended matrix) were developed on lab-scale.

This development started under the support of EU-FP6 MoniQA project and now it is supported partly by OTKA-ANN 114554

Keywords:
reference material, gluten analysis, protein composition, ELISA

DESIGNING ATTRACTIVE HEALTHY HIGH FIBRE PRODUCTS BY USING MATERIAL SCIENCE AND RHEOLOGY BASED GUIDELINES

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The development of new physical and empirical models and⁄or the adaptation of well-established models from polymer and material sciences, in combination with characterization of rheological, thermal behavior and microstructure of food matrices, are valuable tools for obtaining insight in the impact of fiber on processing and on product structure and for developing guidelines for product reformulation. Major reductions in sugar and fat levels in bakery products can be realized by application of classical thermodynamic polymer behavior theories (Flory – 1941; Flory-Fox - 1950) to starch gelatinization, and of theories of rheology of solid foams (Ashby-Gibson – 1983, developed for metallic structures) to texture of bakery products. Based on this approach a range of bakery products high in sugar or fat have and are being reformulated. A cake-type product with zero added sugar (instead of 34%) and 18% fibre instead of 3% was launched successfully on the Dutch market. Higher levels of bran in dough and bread generally results in altered rheological and baking properties compared to products derived from refined wheat flour. We studied the effects of addition of buckwheat bran to dough of refined flour with dynamic mechanical thermal analysis (DMTA) to characterize dough and bread properties. Important parameters – the onset temperature of starch gelatinization and the gluten surface hydrophobicity – were strongly impacted by addition of bran, and by decreased bran particle size. The impact of bran - decreasing gluten surface hydrophobicity during dough mixing and increasing the onset temperature of starch gelatinization during baking was closely related to its role in changing the partitioning of water, as defined by Flory-Huggins, between the polymers in the system. New results of other insoluble, cellulosic fibers and soluble fibers of fibers will be presented, contributing to a more general picture and to new options for developing sensorily attractive products with high levels of fiber.

Reference: Stefano Renzetti and Albert Jurgens (2016) Rheological and thermal behavior of food matrices during processing and storage: relevance for textural and nutritional quality of food.
Current Opinion in Food Science, 9:117–125. Available online at www.sciencedirect.com

Keywords:
Sugar and fat reduction, starch gelatibization , Gluten surface hydrophobicity, Number average MW

INTERACTION OF THAUMATIN LIKE-PROTEINS WITH B-GLUCAN IN BARLEY

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Dietary fibers (DF) are carbohydrate polymers that are resistant to hydrolysis by enzymes in the digestive tract. DF is mainly classified into water soluble and insoluble types. Water soluble DF consists of non-starch polysaccharides mainly β-glucans and arabinoxylans. β-(1,3,1,4)-glucan is one of the major component of oat and barley endosperm cell walls. A prominent proportion of barley grains is processed into malt, whose quality is predominantly dependent upon endosperm β-glucan metabolism. Higher level of β-glucan grounds poor malt filtration, high wort viscosity, and haze formation. Members of the *cellulose synthase-like (Csl) F* gene family are known to be involved in β-(1,3,1,4)- glucan synthesis but many aspects of its regulation are still unknown. Recently, we identified a thaumatin like-protein (TLP), *HvTLP8,* which interacts with β-(1,3,1,4)-glucan in barley (*Hordeum vulgare* L.). Differential expression of *HvTLP8* has been found to be associated with the amount of β-glucan in barley grains. In germinating barley seeds, β-glucan quantity was decreased with higher expression of *HvTLP8.* In vitro binding assay confirmed the association of purified HvTLP8 with β-glucan. Interestingly, the interaction of purified HvTLP8 protein with β-glucan was redox regulated. Binding was almost completely abolished by reducing agents and was enhanced by oxidants. Currently, we are investigating the role of *HvTLP8* in the regulation of β-(1,3,1,4)-glucan activity by creating knock-down and over-expresser barley mutants. In addition, we are exploring novel TLPs from barley genome and their interaction with β-glucan.

Keywords:
Dietary fibers, β-glucan, Thaumatin Like Protein, Cereals

Parallel Session 8 – Using processing as a touchstone for choosing grain-based food – Fabulous or Flawed?

A FOOD SCIENCE PERSPECTIVE FOR THE CLASSIFICATION OF PROCESSED FOODS

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A strong trend to regulate nutrients' intake through front of pack warnings is expanding along Latin American countries. In the absence of Codex directives on the matter, currently under preparation, Latin-American health authorities have recommended the use of the controversial NOVA food classification system and PAHO's Nutrient Profile Model to draft their regulations. The scientific community worldwide has questioned both the scientific basis and the benefits of the NOVA approach that, in addition, entails a dramatic and unjustified demonization of processed foods and the role historically played by food science and technology.

The NOVA System comprises four groups of products: not processed or minimally processed foods, processed culinary ingredients, processed foods and "ultra-processed products". This classification has great divergence from food classification systems that are used internationally such as the Codex Alimentarius, INFOODS, FoodEx 2 or the IFSAC.

This symposium will describe the current Latin-American regulatory environment and will highlight the efforts various stakeholders in the region, including national authorities, the food and beverage industry, academy and ALACCTA, are doing to assure that front of pack labelling regulations follow good regulatory practices and principles for the benefit of consumers.

The presentation will show from a food science perspective how foods should be classified according to food classifications that have sound scientific background.

Keywords:

Classification of foods, Codex food categories, processed food, ultra-processed foods, minimally processed foods

THE ROLE OF FOOD PROCESSING IN FOOD SECURITY AND FOOD SAFETY

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The world´s population will reach 9.1 billion by 2050; and nearly all will increase in developing countries and urban areas. Humanity will need to sustainably increase food production by 70% and annual cereal production by over 200 million tons to address the demand. This task must come with increased efforts to prevent food loss and waste. The World Health Organization (WHO) defines food security as "when all people at all times have access to sufficient, safe and nutritious food to maintain a healthy and active life" Food processing plays a critical role in achieving security. Processing of cereal grains ensures the availability of drying and storage technologies that not only help address food loss but also help avoid contamination by naturally-occurring toxins such as mycotoxins. Grain processing is one of the oldest and most important of all food technologies; and different processing technologies help improve the microbial safety, nutritional quality and physicochemical properties of cereal grains. As strategies to ensure food security are explored, it becomes more evident that processing of cereal grains will be an essential tool to supply humanity with sufficient, nutritious and safe food.

Key words:
food security, food safety, cereal processing, mycotoxins

PROCESSED GRAIN-BASED FOODS – A NUTRITIONAL BOON OR BAN?

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NOVA[1] recommendations proposed by Monteiro et al. suggest avoidance of processed food (PF) and ultraprocessed food (UPF). They purport that such advice will address obesity and chronic disease. Data supporting such advice will be reviewed and critiqued. Concerns include: (1) that level of processing matters more than a food's nutrient composition and dietary role; (2) that support for NOVA is based on *post hoc* analyses of food intake or food acquisition data; (3) that studies showing associations may not adjust for confounders that impact outcome measures; (4) that food categorization is inconsistent across studies; (5) that needed research on consumer understanding of NOVA is lacking; (6) that consumers have the time, skill and needed resources to follow NOVA; (7) that foods made at home, irrespective of their nutritional value, are more healthful than those from industrial sources.

Cereal scientists should be concerned about NOVA since almost all breads and cereal products are deemed as PF or UPF. Avoidance of these foods that make up most of the intake from the grain group could decrease intakes of dietary and cereal fiber, folic acid or B vitamins.

NOVA will be compared to vetted approaches such as the DASH diet that include a balance of foods from all levels of processing. Such approaches are actionable and affordable and may be more likely to address shortfall nutrients and dietary fiber and to have greater likelihood of fitting today's consumers.

Monteiro CA, Cannon G, Moubarac JC *et al*. (2015) Dietary guidelines to nourish humanity and the planet in the twenty-first century. *Pub Health Nutr* 18, 13, 2311

Monteiro PH, Monteiro CA, Cannon G, *et al.* (2016) NOVA. The star shines bright. *World Nutrition*. 7, 1-3, 28

Keywords:

NOVA, processed food, ultra processed, minimally processed, nutrition, dietary guidance

[1] Not an acronym

POSTER PRESENTATIONS

01 Quality and Quality Assessment

MILLING AND RHEEOLOGICAL PROPERTIES OF WHEAT (TRITICUM AESTIVUM L.) IN KENYA

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Wheat (*Triticum aestivum L*.) is a major staple food crop in many parts of the world and in terms of cultivated area and as food source. In Kenya, it is ranked second after maize in cereal crops research priorities. The milling and bread making properties of 47 Stem Rust Advanced Yield Trial lines and three Kenyan wheat varieties grown in Eldoret, Mau Narok and Timau in year 2010 were screened to determine the contribution of genotype and environment to the variation observed on flour extraction (FE), flour water absorption (WA), dough development time (DDT), flour protein content (PC) and flour gluten content (GC) using Near Infra Red Spectrophotometer and AACC methods. Trait stability and the effects of the environment on the expression of the milling and baking traits were evaluated using genotype (G) by environment (E) interaction study model. The analysis of variance (ANOVA) showed significant differences ($P \leq 0.05$) among the genotypes (G), sites and G*E interaction for the traits analysed. Levels of FE, WA, DDT, PC and GC ranged from 50 to 81 percent; 26.7 to 38.8 mls; 73.4 to 77.6%; 1 to 3.75 minutes; 8.8 to 15.6 percent and 17 to 37.3 percent respectively. Correlation coefficients between wheat quality traits were significantly different ($P \geq 0.05$) from one another. From the mean quality data for all the test parameters, a dendogram was derived depicting the levels of genetic similarity between wheat varieties based on the quality traits. For all the quality traits, at 70% similarity coefficient, four cluster groups were delineated which comprised of the four wheat groupings of wheat in Kenya based on dough rheology of wheat.

Keywords:
wheat, flour extraction, water absorption, dough development time

TECHNOLOGICAL QUALITY OF WHEAT (*Triticum aestivum* L.) IN THE SOUTHERN ARGENTINIAN PAMPAS: PERIOD 2000-2016

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The aim was to characterize the relationship among wheat quality parameters, varietal traits and environmental conditions of the southern Argentinian pampas (Lat.: -63.393 to -56.708; Lon: -36.009 to -41.034) during the period 2000-2016. This characterization was carried out with 3.150 random samples collected from farmers fields. Every sample was classified according to three quality groups (QG1, QG2 and QG3) and three geographical origins (south-east, central-south and south-west). Physical and chemical analyses were performed to characterize the technological quality of wheat and flour obtained from each sample. ANOVAs and principal components analyses were carried out considering the influence of geographical origin on grain yield, test weight, grain protein, ash content, flour milling yield, falling number, colour, wet gluten, gluten index, alveograph and farinograph parameters. Pearson's test was used to correlate protein content with industrial quality parameters ($P < 0.0001$). The results suggest that the south-east area was associated with higher yield and lower quality, whereas the central-south area was stable. The high farmers adoption of wheat varieties of good quality (QG1 and QG2) ensures that the industry can satisfy its requirements. The large region analyzed shows a high potential for producing wheat with variable qualities.

Keywords:
screening, grain quality, flour quality, Argentina

TRITICUM DURUM: APPLICATION OF AN INDEX TO PREDICT QUALITY IN ARGENTINIAN WHEAT

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Durum wheat breeding has been performed considering robust parameters in order to satisfy the demand of the industry. The Laboratory of Industrial Quality of Grains (CEI Barrow) is the only one with suitable equipment and methodologies for breeding selection according to technological traits sought. The increasing complexity and diversity of analyses used to characterize the technological aptitude of durum wheat materials, led to develop a quality index (Q) with the most significant parameters of quality. Thus, durum wheat cultivars and advanced breeding lines could be compared. Q has been developed taking into account grain quality parameters (thousand kernel weight, vitriosity and protein) and semolina quality parameters (semolina extraction rate, gluten index, colour and farinograph energy level).

This work is aimed to check the effectiveness of Q to detect differences among genotypes. Six commercial varieties were selected from comparative yield trials carried out during 1998⁄99 to 2013⁄14 under the same technological conditions in different Argentinean sub-regions. Samples (n=340) were analyzed to determine a Q value for each variety. An ANOVA was performed and means were compared at the 5% level. The varieties differed significantly (LSD=0.25157 and CV=14%) indicating that although the breeding has reached world standards associated to colour, protein and yield, the quality of varieties differs and could be detected by Q as an efficacious tool to compare durum wheat materials.

Keywords: durum wheat, quality evaluation, Argentina

EFFECT OF CAROB ADDITION ON CHEMICAL COMPOSITION AND PHYSICAL QUALITY OF COOKIES

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Carob tree (*Ceratonia siliqua*), which is a plant native to Mediterranean countries, produces a fruit called carob that when milled produces a cocoa-like powder. The carob pulp is rich in sucrose, glucose, fructose, proteins and micronutrients. Besides having no allergenic or stimulating agent, such as cocoa theobromine, it has a high antioxidant potential, contributing to the fight against free radicals and chronic degenerative diseases. Cookies are a product highly consumed worldwide. The objective of this work was to investigate the effect of carob addition on the chemical composition and physical quality of the cookies. Control cookie without carob (with 30% cocoa, to simulate the dark color of the carob) and cookies containing 10, 30 and 50% carob were produced. The wheat flour was obtained from the cultivar BRS Pastoreio (grain hardness index= 39 or medium soft; grain falling number= 431 s; gluten strength= 61 x 10^{-4}J, elasticity index= 28%, and P⁄L ratio= 0.6; farinograph stability= 2.4 minutes; gluten index= 76; and, brightness, L*= 96). The ingredients of the basic formulation were: wheat flour, sugar, salt, sodium bicarbonate, hydrogenated vegetable fat, and dextrose solution. Analyses of chemical composition and physical characteristics of the cookies were performed. The data were treated by ANOVA, and the means were compared by the Duncan test ($p \leq 0.05$). The carob added in 10, 30 and 50% levels, changed, proportionally, the composition of cookies: significantly increased ash content, acid and neutral detergent fiber, and total carbohydrates contents; and decreased lipid, protein and sugar contents. The control cookie presented moisture smaller than cookies added with carob, but its chemical composition and water activity results were similar to 10% carob cookie. In relation to physical characteristics, the diameter and expansion factor increased significantly from the control to 50% carob cookie. There was no significant change in cookie specific volume. The cookie color became darker (low L* value) as the percentage of carob increased, and the 10% carob cookie presented a more similar color to the control. The application of carob flour can be an alternative, in spite of its high cost, to produce a functional food, once carob added to cookie formulations causes no detrimental effects in its physical characteristics.

Keywords:
Ceratonia siliqua, cookie evaluation, functional food

PHENOLIC ACIDS IN PENTOSANS OF WHEAT FLOURS AND RELEVANCE IN QUALITY PREDICTIVE PARAMETERS

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Strategies to improve baking quality of wheat flour products have been widely studied. Although the content and quality of proteins have mostly allowed to predict flour baking quality, we have recently proved the strong link between arabinoxylans (AX), both their quantity and structure, with rheological and protein related parameters [1]. Phenolic acids are esterified to AX in wheat flour. They have been described as being involved in the interactions that occur between AX and proteins during dough formation. Despite phenolic acids are described as being in a very small proportion in flour, it has been reported their importance in the baking process [2]. In the present work we propose to study the relationship of phenolic and particularly ferulic acid (FA) with the parameters associated with AX and proteins. Five wheat flour samples, obtained from up to 3 different wheat varieties grown in 2 locations, were studied. Water extractable (WE) and water un-extractable (WU) AX amount in flour and the relation Ara⁄Xyl were determined according to Tomati et al. [3]. Molecular weight distribution (MWD) in WU-AX, phenolic acids and FA were estimated according to Garófalo, L. (2017) [1]. Correlation and PCA analysis were performed using the software package Statistica v. 6.1. AX content was found to be between 0.7 and 1.2% of flour. The distribution pattern of Ara branches varies for WE-AX and WU-AX, being lower in the latter ones. MWD of the WU-AX fraction presented a bimodal distribution, with higher amounts between 3 to 5 kDa and between 9 to 17 kDa, being evident large differences in the relative amounts of both groups. No free phenolic compounds were detected. The phenolic compounds were found to be between 0.4 and 2.4% of AX. FA represents 70-95% of total phenolic compounds. It was found that flours with large amounts of phenolic compounds have a strong tendency to contain a high proportion of AF. The amount of FA was directly linked to the MW of the smaller WU-AX fraction, and inversely with the proportion between both fractions. In summary, the amount of phenolic compounds and specifically AF are strongly linked to the structural properties of AX, mainly insoluble ones, which is expected to affect the rheological properties of wheat dough.

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Keywords:
Arabinoxylans, Wheat flour, Ferulic acid, Breadmaking quality

COMPARISON BETWEEN PURPLE CORN (ZEA MAYS L.) HALF-SIB FAMILIES FROM ARGENTINA: PHENOLIC COMPOUNDS AND ANTIOXIDANT PROPERTIES

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The objective of this study was to characterize agronomically eight half-sib families of purple corn adapted to central Argentina and to compare their total phenolic compound content and antioxidant activity. Eight half-sib families were selected from original germplasm (POr) from CIMMYT, Peru and Bolivia, and their progenies were grown during two cycles (2013-2014 and 2014-2015). The genotypes were agronomically characterized; centesimal composition, *in vitro* protein digestibility (PD), total polyphenol (TPF) content, total anthocyanin (AN) content and antioxidant capacity (AC) through Ferric-reducing ability(FRA), and ABTS•+ radical cation scavenging activity (RCSA) were determined from whole grain flour. Hard white corn (BL), popcorn (PS) and *opaque-2* (O2) maize flours were used as controls. The results were statistically analyzed by linear mixed models (MLM), analysis of variance (ANOVA), and Pearson correlation ($p < 0.05$). Field yields showed significant differences between purple corn progenies (from 16.6 to 46.5 q⁄ha in 2014 and from 14.4 to 60.4 q⁄ha in 2015). TPF and AN showed a wide range of variation between genotypes (from 439 to 1934 mg gallic acid⁄100g and from 88 to 291 mg cyanidin-3-glucoside⁄100g, respectively); they were strongly correlated (r=0.89). Progenies that presented the highest TPF and AN showed the highest AC (from 53.6 to 233 of FRA and from 14 to 55 µmol TROLOX⁄g of RCSA), surpassing initial genetic material (POr) and controls. The genetic variance represented the greatest contribution to the total variability (> 70%) in TPF, AN and AC indicating a strong effect of genotype in these characteristics. The differences between the individual progenies will allow us to identify agronomically adapted genotypes with higher PF and AC and to continue with a new recurrent selection cycle to obtain varieties with improved bioactive compound content and high antioxidant capacity.

Keywords:
purple corn, polyphenol, anthocyanin

WHEAT FLOUR SOLVENT RETENTION CAPACITY: REPEATABILITY AND REPRODUCIBILITY PERFORMANCES OF A NEW AUTOMATED MEASUREMENT METHOD

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Solvent Retention Capacity (SRC) is the analytical method measuring the contribution to water absorption of the main functional flour polymers (gluten protein, starch, pentosans). The first approved standardized method recognized in the industry was AACCI Method 56-11.02. However, this manual method is very operator-dependent due to the need for consistent shaking within the test. This human execution difference can introduce variation in the results, making it difficult for the SRC parameters to be efficiently integrated to flour specifications. To address this situation, CHOPIN Technologies developed an automated system aiming to eliminate all potential impacts of the operator on the test. This method was evaluated through a collaborative study involving twelve laboratories that analyzed twelve flour samples in duplicate with the four solvents (Water WA-SRC, Sucrose SUC-SRC, Sodium Carbonate CAR-SRC, and Lactic Acid LAC-SRC). In this study, average repeatability (S_r) and reproducibility (S_R) values, respectively, were 0.53 and 1.08 for WA-SRC; 1.05 and 1.43 for SUC-SRC; 0.67 and 1.15 for CAR-SRC; 0.86 and 1.94 for LAC-SRC; and 0.59 and 1.12 for the Gluten Performance Index (GPI-SRC). These results were on average two times lower than those from the manual method for SUC-SRC, LAC-SRC, and CAR-SRC, and 10% lower for WA-SRC. By offering an extended field of application and improved accuracy, the new SRC-CHOPIN method provides an alternative for users in both research and industry, whose work demands the most precise testing methods available.

Keywords:
SRC solvent retention capacity wheat flour

EVOLUTION OF THE PROPERTIES OF FLOURS DURING STORAGE UNDER DIFFERENT TEMPERATURES

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According to the location or the economic possibilities of industries, it is sometimes difficult to ensure a proper storage environment for cereal products. The objective of this study is to evaluate the evolution of the rheological properties and functionalities of flours during storage under different conditions. One French wheat sample was milled thanks to the CHOPIN CD1 mill according to 2 different milling processes to obtain white flour and whole meal flour (standard protocol AACC 26-10.02 and adapted protocol for making whole meal flour). Both samples were homogeneously separated in 3 fractions which were stored under 3 different temperatures (4°C, 20°C and 30°C), all other conditions being equal. The rheological quality of those samples was tested during 4 months every 2 weeks thanks to the Mixolab ("Chopin+" protocol; AACC 54-60.01) and the SRC-CHOPIN (AACC 56-11.02). The Mixolab results show that whatever the flour and the temperature, the storage induces an increase of the stability (+37% in average) and an increase of the gelatinization intensity. The SRC results show that the retention capacity of the damaged starch increases for the white flour while this parameter is not impacted for the wholemeal flour (30°C). On the contrary, for the wholemeal flour, the retention capacity of the glutenins increases while it is not impacted for the white flour. The pentosans retention capacity increase linearly at 30°C whatever the type of flour tested (white flour: R^2=0.87; wholemeal flour: R^2=0.95). Mixolab allows controlling the evolution of the rheological properties while the SRC permits the control of the functionality of stored flour.

Keywords:
Storage control, Mixolab, SRC CHOPIN

EVALUATION OF THE IMPACT OF CRICKET POWDER INCORPORATION ON THE RHEOLOGICAL PROPERTIES OF WHEAT DOUGHS AND ON THE FINAL PRODUCTS CHARACTERISTICS

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Flours made from insects are an excellent way to improve the nutritional composition of the cereal products. However, they certainly have important impacts on doughs rheological properties. It is then necessary to assess the rheological behavior of cricket powder alone and to evaluate the impact of cricket powder addition on the quality of doughs and the characteristics of breads. 4 cricket powders provided by 2 suppliers were tested alone using the Mixolab thanks to a specific protocol ("Cricket protocol"). One sample was added at different levels into wheat flour (0%; 1.5%; 2.5%; 3.5%; 5%; 6.5%; 7.5% and 10%). Those blends were analyzed thanks to the Mixolab ("Chopin+" protocol; AACC 54-60.01) and the French bread making method (NF V 03-716). The analysis of cricket powder alone reveals that the rheological quality of the samples can vary a lot according to the supplier but also within the samples from 1 supplier. The analysis of the blends show that the quality of the flour decreases gradually when cricket powder is added. The dough stability decreases as well as the stability of the hot formed gel (-166% on the C4-C3 value). The volume decreases (from 1562 ml at 0% to 598 ml at 10%) as well as the total score. These phenomena become significant from 3.5% incorporation. Finally, correlations prove that Mixolab gives a good prediction of the bread making data (R^2=0.99 between the volume and the C3 values). Mixolab is able to analyze the rheological properties of various cricket powders, alone and blended to wheat flour. Cricket powder use in French bread-making is possible if not exceeding a certain amount. The use of the Mixolab can help define and adapt this limit according to the respective quality of cricket and wheat flours used.

Keywords:
Cricket powder, Mixolab, Bread Making Tests, Rheology

30 YEARS IN THE WHEAT CROP QUALITY REPORT OF ARGENTINE CENTRAL REGION

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Until 1987 there was not carried out a wheat crop quality report in Argentina so the Wheat and Soybean Quality Lab. from INTA Marcos Juarez, Córdoba, started to analyse the wheat of the country central region. This report is published as soon as the wheat harvest end in December of every year and it is the only one at that moment, being an important reference for milling industry and export. The information generated from 1987 to 2017 (30 years), summarizes the quality evolution of wheat crop in an important producing area of the Humidy Pampa. Samples were taken in storage plants at harvest and represent between 150 thousand and 1 million tons annually of the North II wheat subregions. According to the results quality characteristics was good except for isolated years with environmental or desease problems. The 30 years test weight average was above 79 kg⁄hl corresponding to Grade 1 of commercialization. In 21 years the protein content average was 11.7% (13,5% moisture basis), over 11% which is the marketing basis for protein bonus. The gluten content average was 27.7%, with only five years below 25%, the minimum value demanded as good by the Argentine miller. The alveogragh W average was 270 joulex10^{-4}, with values higher than 250 joulex10^{-4} in 19 crops. The tenacity⁄extensibility ratio was higher than 1, suitable to achieve a good loaf volume of bread as observed in almost all years. Farinograph stability average was over 15 min, minimum limit required by Brazil the main buyer of Argentine wheat. The region results posittion it without problems in technologycal parameters, adequated for a great diversity of farinaceous products.

Keywords:
Argentinian wheat, quality, central region, 30 years

COMPARISON OF SOME LANDRACES AND A MODERN WHEAT IN TERMS OF QUALITY, FUNCTIONAL PROPERTIES AND GLUTEN/GLIADIN CONTENT

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The aim of this study was to compare the quality and functional properties and quantity of gluten and gliadin in some wheat landraces (Sünter, Siyez and Karakılçık) and a modern bread wheat (cv. Tosunbey). Tosunbey is a hard white winter wheat with strong gluten properties while Sünter (*Triticum aestivum*), Siyez (*Triticum monococcum*) and Karakılçık (*Triticum durum*) are landraces grown in Turkey developed by farmers through years of natural and human selection.

The protein contents of the whole wheat flours of Tosunbey, Sünter, Siyez and Karakılçık were 13.8, 13.0, 16.0, 14.8% and the Zeleny sedimentation values of their flours were 60, 21, 10, 12 ml, respectively. The phytic acid content of wheats were found as 797, 1426, 1125, 1606 mg/100g for Tosunbey, Sünter, Siyez and Karakılçık, respectively. Tosunbey had highest total arabinoxylan content compared with the landraces Sünter, Siyez and Karakılçık while Karakılçık had the highest water extractable arabinoxylan content as compared to the others. Beta glucan concentration of a modern wheat (Tosunbey) had the highest value as 0.65% compared with the landraces.

Quantity of gluten and gliadin were determined by using antibody-based technologies, G12 and R5 assays. R5 Assay is an enzyme immunoassay for the quantitative analysis of gliadins and corresponding prolamines while G12 Assay is a sandwich enzyme-linked immunosorbent assay (ELISA) that determines a quantitative level for the presence of specific immunotoxic gluten fragments. Significance analysis results showed that R5 ($p<0.05$) and G12 ($p<0.01$) results of wheats were significant.

As expected, the gluten concentrations obtained by the G12 assay were higher than the gliadin concentrations obtained by using the R5 assay for all wheats. The Sünter wheat resulted in higher gluten and gliadin concentration values with G12 and R5 antibodies compared with modern bread wheat Tosunbey, landraces Siyez and Karakılçık. Compared to bread wheats (Sünter and Tosunbey), durum wheat landrace (Karakılçık) and Siyez landrace had lower level of epitopes reactive towards ELISA G12 and R5 antibodies.

Keywords:
landrace, wheat, quality, functional properties

CHARACTERIZATION OF QUALITY TRAITS DIVERSITY AND THEIR GENETIC BASIS IN THE WILD WHEAT RELATIVES TRITICUM URARTU

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Triticum urartu (2n = 2x = 14, genome A^uA^u) is the wild diploid progenitor of durum and bread wheat, still growing across the Fertile Crescent. Its natural populations feature allelic diversity for numerous traits including grain quality. Because of their broad diversity and environmental adaptation, the fine characterization of *T. urartu* natural accessions may provide wheat breeders with new alleles potentially contributing to wheat improvement. To further the characterization of *T. urartu* diversity, we assembled an *ex situ* collection of 298 accessions sampled across the Fertile Crescent and we analyzed it for genetic diversity and grain quality. The collection was genotyped using a double-digestion RAD sequencing, producing 75,511 high-quality genome-wide SNPs reporting a wide genetic diversity and complex evolutionary history. The collection underwent detailed characterization for grain quality traits. Gliadins and glutenins fingerprinting of seed-storage proteins was conducted using A-PAGE and SDS-PAGE. More than 10 different alleles were identified for ω gliadins subunits, while for high molecular weight subunits glutenins we discovered 7 and 5 alleles for the *x* and *y* subunits respectively. To evaluate the bread-making aptitude of *T. urartu* samples, a SDS-sedimentation test on whole meal flours was performed. The collection showed broad variability, even including some accessions approaching good bread-making quality (volumes > 40 ml). Finally, the content in total carotenoids was measured by spectrometry, showing high quantities for most accessions, about 5 times higher than in bread wheat (0.1 - 2.4 mg⁄Kg dm) and 2 times more than in durum wheat (1.5 - 4.0 mg⁄Kg dm). Finally, we combined trait data and genotypic data to perform a genome-wide association study (GWAS) to identify genomic loci controlling quality traits in *T. urartu*. The simultaneous production of a nested association mapping (NAM) population from 13 divergent *T. urartu* accessions, currently at the F_4 generation, will contribute to boost QTL mapping efficiency in *T. urartu* for quality and agronomic traits.

Keywords:
Genetic resources, seed-storage protein, genome-wide-association study, nested association mapping

GLUTOPEAK METHOD IMPROVEMENT FOR GLUTEN AGGREGATION MEASUREMENT OF WHOLE WHEAT FLOUR

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A shear-based device, the GlutoPeak, was developed to measure the aggregation behavior of gluten. In this study, the GlutoPeak testing method was optimized and applied for the gluten aggregation evaluation of WWF of different particle size ranges. A two-phase study was conducted. In the first phase, the sample⁄solvent weight ratio, mixing speed, and testing temperature were adjusted to different levels for obtaining more repeatable Peak Maximum Time (PMT) and Maximum Torque (MT) of two commercial WWF samples. The temperature had a high effect on the repeatability of the PMT, while the sample⁄solvent weight ratio and mixing speed had low impact on the repeatability of both the PMT and MT. In the second phase, four commercial wheat samples were milled to WWFs of different particle size ranges. The gluten aggregation of the WWF was measured using the optimized GlutoPeak parameters, which were 8-g WWF and 10-g 0.5 mol⁄L $CaCl_2$ solvent with a mixing speed of 3,000 rpm and test temperature of 20˚C. The PMT significantly decreased (with the exception of SW) and MT significantly increased with a decrease in WWF particle size. Compared to the Mixolab and Farinograph, the GlutoPeak method took less time and provided significantly different ($p < 0.05$) results for WWFs of different particle size ranges.

Keywords:
Whole wheat flour, GlutoPeak, Particle size, Gluten aggregation

ORGANIC ACID AND B-GLUCANASE AS NATURAL PRESERVATIVE

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In present society, awareness about the origin of products described in labels has been increasing. Artificial ingredients are the conflictive ones whose appearance in labels causes concern. A decrease of these ingredients would be desirable so, in consequence, the concept of clean labeling has merged. In bread market, compounds used as preservatives are complex but needed to remove from label, due to their inherent function as preventing molds and yeast to appear.

The main way of increasing shelf life in bread is introducing preservatives in dough and spreading them in its surface as well. Generally, surface preservatives have chemical composition, like sorbic acid or potasic sorbate, but in order to remove this type of ingredients on labeling, organic and enzymatic treatments have been studied. Molds and yeasts are the main responsible of spoilage in breads. Beta-glucanases are enzymes that hydrolyze non-starch polysaccharides and its activity is related with the degradation of plant cell wall polysaccharides. As a result, a preservative containing beta-glucanases' activity should break the cell wall in mold, increasing bread's shelf life. This work aims to develop an enzymatic mix with organic acid as a natural preservative. Propionic acid is a organic acid produced naturally by citrus, frequently used in preservatives. Based on shelf life test in loaf bread, we found that certain beta-glucanase enzyme mixed with propionic acid, decrease the molds production at a similar rate of chemical ones, obtaining a natural preservative applicable in clean labeling.

Keywords:
ENZYME, NATURAL, PRESERVATIVE, BETAGLUCANASE

PIGMENTED VARIETY OF CORN (*Zea mays* L.) IN TOCHIMILCO PUEBLA

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Corn as a staple food of which approximately one third of that production 1025 millions tonnes is colored specifically, in Tochimilco, Puebla Mexico, the use of creole seed, remains mainly of the blue and red variety, closely associated with a good quality determined by the structure and composition of the grain, is maintained. Blue and red corn is a pigmented variety of corn (*Zea mays* L.), whose main colorations are found in the pericarp and the aleurone layer of the grain, closely related to the content of anthocyanins present in them. Anthocyanins are important because of the sensory characteristics they bring to food, as well as their antioxidant properties.

The corn populations studied here were located in two ranches in Tochimilco, Puebla, with a predominance of grains with red and blue tones. In the quality tests, it was observed that they comply with the CODEX stand 153-1985 and the necessary specifications for the quality and their commercialization exceeding the established standards. The grain pigmentation was located in the aleurone layer of blue corn; in the red corn, in the auleurone layer and the pericarp. Regarding this, differences were obtained between each one of the analyzed samples, for the obtaining of the anthocyanin, as well as the different treatments used for the extraction, being the most effective the treatment 4 that consisted of a medium of pH 2, with a temperature of 75 ° C and a time of 2 hours. In the other hand , in the blue corn aleurone layer, a higher content of monomeric anthocyanins was observed, determined by the differential pH method, which was 855.78 mg／kg (cyanidin-glucoside base), for the aleurone layer of red corn was 549.41 mg／kg. (base cyanidin-glucoside).

Keywords:
anthocyanin, aleurone, corn

HMW-GS EFFECTS ON VISCOELASTICITY OF GLUTEN AND DOUGH AND ITS RELATIONSHIP WITH THE BREADMAKING QUALITY OF WHEAT

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Effects of high molecular weight glutenin subunit (HMW-GS) on viscoelasticity of wet gluten and wheat dough, and its relationships with mixing, extensibility and breadmaking parameters were investigated by creep-recovery using Kelvin-Voigt model on 19 hard red winter wheats. Gluten samples with *Glu-A1* 1 and 2* only show significant differences in retardation time

Keywords: *Creep recovery, High molecular weight glutenin subunit, Wheat quality*

QUALITATIVE ASSESSMENT OF WHEAT VARIETIES/LINES FOR THE DEVELOPMENT OF BIOFORTIFIED WHEAT (*Triticum aestivum* L.)

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Up to two billion people worldwide consuming cereals have Fe and Zn deficiency. Wheat as a staple diet contributes 1.9 percent share in GDP of Pakistan. During 2016-17 National Wheat Breeding program at Faisalabad-Pakistan analyzed 240 samples of wheat varieties/lines both from irrigated and rainfed National Uniform Wheat Yield Trials (NUWYT) for quality characteristics such as protein, gluten, starch content, α-amylase activity, 1000 grain weight, test weight and iron and zinc concentration. The analysis revealed that 1000 grain weight ranged from 23.9-50.2 in irrigated and 31-42.0 g in rain-fed conditions while test weight range was found to be 59.9-75.8 (Irrigated) and 64.5-79.9 Kg/hl (rain-fed). Protein and gluten content ranged between 12.0-16.1 and 13-16.2 and 21-34 and 21-38% in irrigated and rainfed trial, respectively. Starch content was found to be 51.8-57.1 and 51.9-56.1% in irrigated and rain-fed set, respectively. Falling no. (FN) values were recorded in the range of 352-814 in irrigated and 352-814 sec in the rain-fed set. Most of the varieties/lines had narrow range of Zn (31-32.6 and 31.2-33.9) and Fe (35-40 and 35-43 ppm) in irrigated and rainfed trial, respectively. Statistical analysis of both sets showed gluten and protein being directly correlated to each other, showing a positive correlation with Fe and Zn but a negative one with starch. In both sets, a direct correlation of FN with starch was observed only in rainfed set. To overcome iron and zinc deficiency among vulnerable population, there could be several approaches such as fortifying wheat flour with iron and zinc, adding blackstrap molasses in the bakery products, however, the most preferred and sustainable option is the development of biofortified wheat varieties and makes those available to the vulnerable masses.

Keywords:
Quality, Assessment, Minerals, Biofortification

EFFECT OF HPMC VISCOSITY ON GLUTEN FREE CRUMB GRAIN STRUCTURE

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Hydrocolloids have been very useful as bread improvers in breadmaking due to their capacity to control both rheology and texture of aqueous systems. Nevertheless, there is scare information about the role of hydrocolloids viscosity in developing a network similar to gluten functionality that leads to aerated bread structures. The effect of different hydrocolloids viscosities and hydrations on the crumb structure of gluten free bread were studied. A range of hydroxypropylmethylcellulose (HPMC) with similar backbone and percentage of methoxyl and hydroxypropoxyl residues was selected in order to vary the viscosity (100 mPa.s, 4000 mPa.s, 15,000 mPa.s) while keeping the main chemical structure, using three HPMC levels (1%, 2%, 3%) and hydration levels (90%, 100%, 110%). High-resolution images (600 dpi) of three central slices from each sample were captured using a high-resolution scanner (HP Scanjet G3110) and then analysed to obtain the morphogeometry and crumb cell characteristics by an image analysis program (ImageJ, NIH, USA). To study the morphogeometric characteristics of bread samples, 2D slice area (mm^2) and 2D slice perimeter (mm) were considered. For the crumb grain structure analysis mean cell area (mm^2), cell density ($cells/cm^2$), cell circularity (from 0 (square) to 1 (perfect circle) and surface porosity (total cell area/ total studied area (%)) were annotated. All the parameters, except surface porosity, were affected by one or more of the factors. The differences in the 2D bread slice area were significantly correlated with HPMC level (*P*-value 0.0000), the higher amount of hydrocolloid the larger slice area. Moreover, hydrocolloid viscosity has statistically significant effect on the slice perimeter (*P*-value 0.0091), cell density (*P*-value 0.0139) and mean cell area (*P*-value 0.0097). Both hydrocolloid and hydration levels had significant effect in the cell circularity. Hydrocolloid viscosity and level, besides batter hydration should be altogether defined when designing lean rice-based formulation.

Keywords:
hydrocolloid, crumb, gluten free, bread

DEGRADATION OF CAROTENOIDS PROVITAMIN A IN MAIZE AND ITS ASSOCIATION WITH PHYSICAL, CHEMICAL AND GENETIC TRAITS AT GRAIN

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Retention of carotenoids in seeds of staple crops, especially those carotenoids provitamin A activity, may have a substantial impact on nutritional value of crop for human populations that consume them. Therefore, the objectives of this study were: assess stability of carotenoids provitamin A (proVA) in biofortified maize genotypes, during storage conditions, and relate it to physical, chemical and genetic traits of maize grain. The results suggest that stability along the assessed genotypes is greater in xanthophylls; B-cryptoxanthin (BCX), xanthophyll with proVA activity shows lower degradations than B-carotene (BC); this degradation seems to depend on the initial amount of BC, at least for some maize genotypes evaluated in this study. In addition, positive correlation between concentration of BC and floury endosperm and BCX with vitreous endosperm, suggests that stability may be due to the physical position of these compounds in the endosperm and its relationship with compounds such as tocopherols present in kernel. On the other hand, association of degradation values and genomic sequence of carotenoid cleavage dioxigenase enzymes (CCD1 and CCD4) throws 3 and 6 significant SNP for the sequence of CCD1 and CCD4 associated with the degradation of BCX and BC, respectively. These results suggest improvement alternatives of carotenoids proVA stability at biofortified maize and emphasize the importance of improving more stable compounds such as BCX.

Keywords:
Maize, stability, B-cryptoxanthin, Provitamin A

INVESTIGATION OF THE EFFECT OF THE SYNTHESIZED 5,6-DINITRO-2-METHYL-1H-BENZIMIDAZOLE ON GERMINATION OF SOME WHEAT VARIETIES

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Benzimidazole and its derivatives are an important group of heterocyclic compounds that show diverse pharmacological properties such as antitumor, antimicrobial, antihypertensive, antiviral, antiulcer, anticonvulsant, anti-inflammatory activities etc. More recently, selected benzimidazole derivatives have been widely used in agriculture and in veterinary medicine.

The present study was designed to determine the effect of 5,6-dinitro-2-methyl-1*H*-benzimidazole on the wheat germination characteristic. For this purpose, three cultivars of bread wheat (Tosunbey, Bayraktar 2000, Demir 2000) and three durum wheat (Eminbey, Kızıltan-91, Çeşit 1252) were used.

5,6-dinitro-2-methyl-1*H*-benzimidazole was synthesized by nitration reaction of 2-methyl-1*H*-benzimidazole using concentrated sulfuric acid and fuming nitric acid and its solution in methanol was prepared at 10^{-6} M for germination test of wheat seeds.

Germination was carried out in the germination chamber at 20°C in the dark. At the end of the 8th day of germination, root and shoot lengths, shoot and root fresh and dry weights were determined.

Bayraktar 2000 is the wheat variety with the highest stem lengths and root lengths whileTosunbey is the cultivar with the lowest shoot length and Çeşit-1252 is the cultivar with the lowest root length. Besides these, Bayraktar 2000 has the highest germination rate. The results were evaluated as statistically significant. Data were analyzed using JMP 7.0 statistical software (SAS Institute Inc.). According to the result, a significant correlation was obtained between shoot length value and shoot fresh weight (0.704*) and root length value (0.642*).

Keywords:
benzimidazole, germination, wheat

IMPORTANCE OF ARGENTINE WHEAT PRODUCTION AND QUALITY IN LATIN AMERICA

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Argentina is the main producer and exporter wheat country of Latin America with a production of 18,4 millon ton and 12,6 millon ton of exportation in 2017. There were 47 different destinations being Brazil the main buyer with 40% of total wheat exported. Yields' variation from 2.8 to 3.5 ton per hectare explained the variation in the production influenced by environment and commercial conditions. In the Humid Pampa the last 3 years farmers that apply advanced technology, no tillage (near all the grain production in Argentina) without irrigation produce wheat with yields average of 7 ton per hectare with maximun of 10 ton per hectare. There are important advances in genetic for yield, diseases and quality in wheat breeding programs with the support of Biotechnology The country has genetics for specific uses and demands: red and white hard wheat for breadbaking with three quality levels (98% of its production), durum wheat for pasta (1.5%), soft white wheat for biscuits and cakes and waxy wheat for modified starch industry. A very low percentage of the production is segregated by quality. In general wheat production is a mix of varieties offering to the market commodities wheats. Wheat Marketing is based on Standard of Commercial Grade. Hard wheat price receives a bonus of 2% by protein content percentage or fraction when is above 11% (13.5% moisture basis) if the test weight is superior to 75 kg⁄hl. When protein content is under 10.9% a gradual and accumulative discounts is applied. From 10.9%-10% discounts of 2%, 9.9%-9.0% discounts of 3% and less than 9% discount of 4%. Since 1998 hard wheat varieties are classified by quality in three groups taking into account their commercial and industrial quality performance by a Quality Index. The country is divided into 7 wheat subregions: I, IIN, IIS, III, IV, VN, VS, and the NOA and NEA regions with a smaller production. Those that contribute around 80% to the national hard wheat production are: IV, VS, IIS and IIN. The traditional Durum wheat production area is the IV subregion. To know the wheat quality of each harvest was carried out an annual Official Crop Quality Report since 1998 to 2016 (www.trigoargentino.com.ar). The hard wheat report results show an average of 19 years test weight of 80.22 kg⁄hl, weight per 1000 kernel 33,74 g, ash content 1,797% (dry matter basis), protein content 11.1% (13,5% moisture basis), wet gluten content 25,7%, alveograph W 279 joule $x10^{-4}$, farinograph stability 18.1 min and loaf volume 651 cm^3. In durum wheat the average of the last 5 years show an average test weight of 79.61 kg⁄hl, ash content 1,811% (dry matter basis), protein content 11.4% (13,5% moisture basis), wet gluten content 28.2%, gluten index 53, yellowness b 21, farinogram energy level 27,6 and mixing tolerance index 27(BU). In general, Argentinian wheat meets quality requirements for domestic and international markets.

Keywords:
Argentinian wheat

02 Cereal Processing Technologies

APPLICATION OF DIFFERENT MILLING PROCEDURES AND TO ANALYSIS THEIR EFFECT ON THE PHYSICOCHEMICAL PROPERTIES OF THE WHOLE-WHEAT FLOUR

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The consumption of whole grain products has increased over the last years since they present better health profiles than their traditional counterparts, although the former present lower technological quality. In whole-wheat bread, the detriment is due to a lower gluten proportion in the dough, and to an additional negative effect given by the physical, chemical or biochemical properties of bran. Therefore, the objective of this work was to apply different milling procedures, and to analyse their effect on the physicochemical properties of whole-wheat flour and specific bread volume. Four milling procedures (hammer, roller, blade and cyclotec) were used to obtain flour from three wheat varieties (K. Rayo, Fuste, INTA815). The composition, prediction tests (Solvent retention capacity [SRC], sodium dodecyl sulphate sediment test [SDS-ST]), percentage of glutenin macropolymer (GMP) and damaged starch (DS) of each sample were determined. In addition, farinographic test and baking micro-method were carried out using whole-wheat flour. The results indicated that hammer milling produces samples with a higher percentage of GMP, higher SRC-Lactic, SRC-Sucrose, lower damaged starch content, in accordance with lower values of SRC-Carbonate and SRC-Water. In this regard, hammer milling generated flour of intermediate particle size compared to the other milling procedures and were those that presented the smallest bread specific volume. The three varieties showed the same tendency with the different mills, however, K. Rayo variety presented high specific volume with four different milling procedures. In addition, the effect of particle size of samples was offset with high quality of K. Rayo. The roller milling generated large particle size flour and this procedure allowed to obtain the higher quality bread, and SDS-ST was the test that allowed to predict this result (r: 0.85; $p \leq 0.05$).

Keywords:
whole wheat flour, milling, physicochemical properties

ENZYMATIC WHEAT TEMPERING AND ITS EFFECT IN FLOUR

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Wheat tempering is often be a critical stage during flour production since its quality and milling depends on it. Wheat tempering is affected by the temperature, time and the stability of the process. Therefore the importance to improve the extraction rate (flour amount). The flour amount depends of the milling shear force, and the final quality is affected by it. The parameter damaged starch is also greatly affected. The quantity of damaged starch increases based on milling intensity (shear force). Cellulase is an enzyme produced by fungi, specially *trichoderma*, that hydrolyse cellulose and other polysaccharides as xylanase hydrolyse non-starch molecules in the grain. These enzymes work in optimal conditions, temperature and pH. These enzymes together acts upon the wheat bran's, leaving the endosperm intact and enabling the separation during milling. They separate bran from starch and other components inside wheat grain. This separation could contribute to the quantity of damaged starch and thus to the final bread quality. When damaged starch is too high, the flour absorb higher quantity of water, that then is liberated, because gluten network is responsible for this task. This work aims to develop an enzymatic mix to improve wheat tempering and condition flour. Hard wheat was used during the milling tests performed using Chopin's laboratory mill (CD1). Different enzymatic mix were used for tempering and the resulting flour was baked. Theses essays were done at standard temperature 25°C to keep the enzymes inside their parameters, in order to match the conditions in industrial mills. Different outcomes show that the amount of flour obtained from enzymatic wheat tempering was up to 2% higher than standard treatment without enzymes, which also contributes to final bread quality. Different mixes showed increased extraction rates than standard, however a cost and significance study was done in order to choose the best option, nevertheless the bread with greater ratio of cellulase got higher bread score and the difference in extraction compared with standard was significantly higher than the standard. To validate these results damaged starch was quantified, as well ashes and enzyme activity. Megazyme's kits were used for xylanase activity and laboratory validated method for cellulase.

Keywords:
tempering, cellulase, xylanase, extraction rate

EFFECT ON WHEAT FLOURS ARABINOXYLANS TREATED WITH NEW XYLANASES

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In Uruguay cultivated wheat varieties, mainly *Triticum aestivum*, are destined to obtain leavened and breadmaking products. Although it is in general agreed that the quantity and quality of proteins are determinants of the breadmaking quality of the flours, the rheological properties are of great importance to understand the behavior during the breadmaking. Within the rheological properties, extensibility was described as the main limiting factor in the development of flour doughs from local wheats [1]. It had been also shown that this in turn would be strongly related to arabinoxylan (AX) content and composition in flour. Despite being only 2% in flour, these AX are involved in gluten formation and are very important from the technological point of view during breadmaking [2]. It is for the foregoing that the use of xylanases enzymes has become widespread as flour additive. These enzymes can have several effects, such as decrease the degree of cross-linking or produce water extractable fragments and increase the viscosity [2]. Endo - β - (1, 4) - D - xylanases (EC 3.2.1.8) are glycosyl hydrolases that catalyze the hydrolysis of the internal β - glycosidic bond of the AX chain, generating xylooligosaccharides of low molecular weight with or without branches [3]. Several studies have been developed to understand how the action of xylanases changes the breadmaking properties. It is accepted that obtaining specific enzymatic activities is closely related to the habitat of the isolated microorganism [4]. For this, the isolation of native microbial strains from Eucalyptus tree cultivated in Uruguay is considered of great interest to obtain mesophilic hydrolytic enzymes. Two new xylanases enzymes were obtained from microorganisms isolated from an Uruguayan Eucalyptus tree. One from a yeast, *Pseudozyma* sp. and other from a bacteria, *Bacillus* sp. The novel xylanase enzymes were produced and partially purified. Flours obtained from different Uruguayan varieties and localities were treated with the aforementioned enzymes, and traditional xylanase Pentopan ® mono, in the same conditions of breadmaking process at a laboratory scale. The variation of AX fractions was studied. Transformations between water extractable and water un-extractable fractions were identified, as well as the liberation of oligosaccharides or monosaccharides by the action of the different enzymes. In future experiments, will be determined if there is a relationship between these changes and dough quality.

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Keywords:
Arabinoxylans, Xylanases, Breadmaking quality, Wheat flour

INVESTIGATION OF THE INFLUENCE OF BAKERY ENZYMES ON NON-YEASTED DOUGH PROPERTIES DURING MIXING

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Bakery enzymes are commonly used during breadmaking to manipulate dough handling properties and machinability, and final bread quality. Understanding the influence of these enzymes on dough properties during the early stages of the breadmaking process can therefore help optimize the design of enzymes for the bakery industry. In this study, our objective was to use dough density measurements and low-intensity ultrasound (a technique sensitive to the bubbles present in dough and the mechanical properties of the matrix surrounding them) to investigate how various bakery enzymes affect the properties of lean formula doughs (without the addition of yeast) made from flours of contrasting dough strength. Doughs were prepared by mechanical dough development, using a strong breadmaking flour (from Canada western red spring wheat) and a cookie flour (from Canada western soft white spring wheat) to which various bakery enzymes (glucose oxidase, xylanase, cellulase, lipase, amylase) were added at recommended amounts. Doughs were also prepared under vacuum to examine the effects of enzymes on the dough matrix, independent of any effect due to bubbles. Doughs were maintained under close temperature and humidity control (37°C and 85% RH), dough density was measured, and the ultrasonic phase velocity and attenuation coefficient in the resonance frequency region for bubbles in dough (0.1-5 MHz) were evaluated. Enzyme addition into the dough formulation altered dough's mechanical properties influencing dough aeration during mixing. A significant interaction between enzyme type and flour strength was observed. For strong breadmaking wheat flour doughs, the greatest changes were observed for glucose oxidase, followed by xylanase. For the weak flour doughs, the largest changes were observed for doughs containing lipase and xylanase, with the effect of glucose oxidase being much less pronounced. The enzyme-dependent changes in dough's density and its acoustic signatures demonstrated that some bakery enzymes influence bread crumb structure as early as at the mixing stage.

Keywords:
dough, bakery enzymes, mixing, flour strength

POTENTIAL OF ALMOND BY-PRODUCTS FOR FUTURE FUNCTIONAL BAKERY PRODUCTS

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Almonds (*Prunus dulcis* (Mill.) D.A. Webb or *Amygdalus communis* L.) are used in the preparation of bakery and confectionery products including almond cookies, marzipan and almond milk. The first productive step consists of blanching and peeling the almonds, so as to remove the skin. Skins account for 6-8% of the seed and are mainly destined to cattle feeding. Blanching water represents a waste, involving a disposal expense for the producers.

Therefore, in this work we evaluated the potential of by-products of almond processing, namely blanched skins and blanching water, as ingredients of functional bakery products, due to the presence of phenolic compounds and, in the skin, also fiber. We started by optimizing skin drying; then we quali-quantitative determined the phenolic compounds; finally we assessed the impact of by-products on the rheology of composite dough with wheat flour.

Oven-drying at 60 °C for 30 min was less-time consuming than other time-temperature combinations tested and retained good odor notes. Moreover, this drying condition allowed to maintain higher content of phenolics (814 μg/g d.m. by HPLC) and higher antioxidant activity than sun-drying. Blanching water, on the other hand, had a content of phenolic compounds accounting for 917 μg/mL.

The alveograph and farinograph indices of composite dough was altered by adding dried almond skins at doses higher than 30 and 50 g/kg, respectively. Blanching water did not changed significantly these indices.

In conclusion, almond skins could be used at percentages lower than 30% or in bakery products tolerating a weak gluten network, such as cookies. Blanching water, instead, could be added to any kind of bakery good with no rheological negative effect.

Keywords:
Almond skins; almond blanching water; bioactive compounds; antioxidant activity; rheological properties.

PRODUCTION OF POROUS STARCHES BY ENZYMATIC METHODS

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The porous structures have become materials of great interest due to their adsorptive capacity. However, the shape and size of the pore determines the selectivity of these structures to absorb molecules of different nature. The enzymatic modification of the granular starch leads to porous structures that depend on the type of amylase, the level of amylolysis and the source of starch used in the modification. In order to obtain porous starches with different size, shape, uniformity and periodicity of the porous spaces, the enzymatic modification of starches of different origin (corn, wheat, rice, potato and cassava) using enzymes with various reaction mechanisms, such as α-amylase (AM), amyloglucosidase (AMG) and cyclodextrin glycosyltransferase (CGTase), was carried out. In addition, the impact of the porous structure obtained on the absorption capacity of different starches was studied. Starch structure was captured using scanning electron microscopy and then analyzed to obtain the porous size distribution by an image analysis program (ImageJ, NIH, USA). Several porous structures with diverse pore size distribution depending on the enzyme type and starch source were observed, presenting similar pore area per granule but significantly different pore size frequency. Generally, the amylolytic action on granular starch provokes the formation of deep holes in cereal starches, while more superficial attacks occur in the tuber starches. Both the size of the pores and the pore frequency allowed to increase the ability of starch to bind water molecules, observing a positive correlation between both parameters and the capacity of water absorption (P = 0,5911, r = 0,0061; P = 0,7278, r = 0,0003). Nevertheless, no clear tendency was observed for the oil absorption capacity. Therefore, the use of different enzymes in the enzymatic modification of starches allows the obtaining of porous materials with diverse structures, which determine the ability of these starches to interact with molecules of different nature.

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Keywords:
porous starch, absorption capacity, structure

03 Cereal Foods

CORN TORTILLAS ENRICHED WITH AMARANTH FLOUR (AMARANTHUS HYPOCHONDRIACUS) AND CHIA (SALVIA HISPÁNICA L.)

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The town of Tochimilco in the State of Puebla is one of the main producers of amaranth and chia that despite being seeds with a high percentage of proteins and fatty acids respectively have not been given the adequate diffusion for their consumption. In the present work, the elaboration of tortillas from nixtamalized corn was proposed, incorporating the amaranth and chia flours with the purpose of balancing the malnutrition problems in Tochimilco, by increasing the protein content of this basic food product. Three different formulations were established, F1 (80: 15: 5), F2 (80:10:10) and F3 (80: 5: 15); and a control of nixtamalized flour, where physicochemical, nutritional, sensory characteristics and sanitary markers were evaluated. The tests were carried out for fifteen days from the day of elaboration (T0, T1, T2, T3 and T4); the physical properties of tortillas; weight loss, inflation, rollability, texture, tensile strength at cutting, protein and sensory analysis were performed on the To; the evaluation of the sanitary markers (count of aerobic mesophilic bacteria, total coliforms, fungi and yeasts) as well as the color measurements were carried out from T0 to T4. The results obtained were analyzed using the ANOVA test with a confidence level of $p \leq 0.05$ and mean comparison tests using the Tukey method in the Minitab version 16 program.

In the texture tests, it was observed that the enriched tortillas (F1, F2 and F3) presented better flexibility than the control tortilla, in addition to losing less water during the heating process. Regarding to the protein content, this had an increase in the three added formulations; however, the F2 formulation showed up to 37.77% total protein content, besides that, in the sensory evaluation tests by a hedonic scale it was found that this formulation obtained greater acceptability by consumers than the other two (F1 and F3). The increase of protein in tortillas was achieved through the incorporation of these two flours (chia and amaranth) to benefit the diet of the Tochimilco residents.

Keywords:
tortilla, amaranth, enrichment, chia

AUSTRALIAN AND CANADIAN WHEAT COOKED YELLOW ALKALINE NOODLES: AN INVESTIGATION OF SENSORY EVALUATION AS A FUNCTION OF RHEOLOGICAL AND MECHANICAL ENGINEERING PARAMETERS OF RAW NOODLE DOUGH

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Flours were prepared from 8 Canadian wheat varieties and 9 Australian varieties, representing different classes of their respective country's classification system. Yellow alkaline noodles (1% 60:40 K:Na Carbonate) were prepared, cooked and scored using a Japanese trained sensory panel. Traditional flour parameters; protein, wet gluten and ash content, farinograph and extensograph parameters were determined. Empirical rheological parameters; stress relaxation at 20 s, Peleg's K1 and K2 values as well as mechanical engineering parameters; stress, strain rate, Hencky strain, and apparent extensional viscosity were calculated. Ultrasonic components; wave velocity, attenuation, storage and loss moduli and tan delta values were also determined. These parameters were correlated with the sensory panel's evaluation scores for noodle firmness and springiness at 2 and 5 min, smoothness at 2 min and a calculated stability parameter. No significant correlation was observed between an individual dough parameter (24) and the sensory panelists' noodle texture parameters (6). However, multivariate regression modeling of the individual sensory scores with the various dough parameters yielded good r^2 values of 0.56-0.70 based on only 5 parameters, very good r^2, 0.79-0.96, using 10 parameters and excellent r^2, 0.98-0.99 incorporating 15 parameters. Extensograph RMax, stress relaxation at 20s and Peleg's K1 and K2 parameters were the most dominant in predicting the 10 parameter models.

Keywords:
yellow alkaline noodles, sensory evaluation, dough rheological parameters, multivariate regression modeling

CROSS-LINKED ARABINOXYLANS AS FOOD INGREDIENTS IN MAIZE TORTILLA

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Arabinoxylans (AX) are non-starch polysaccharides present in cereal grains. This polysaccharide is mainly a xylose backbone, with arabinose substituents that may be ester-linked by ferulic acid (FA). AX exhibit interesting functional properties such as emulsifying, texturizing, film-forming and gelling agent among others. AX can form covalent gels by oxidative coupling of FA via chemical or enzymatic agents, resulting in the formation of dimers and trimers of FA as covalent cross-linking structures. The stability of AX gels to changes of temperature, pH and ionic strength allows their passage through the upper gastrointestinal tract being further fermented by colonic microbiota. In addition, AX present hypocholesterolemic, anti-inflammatory and anti-obesity effects which have been related to changes in gut microbiota. Therefore, AX and specially cross-linked AX, are interesting ingredients for food industry, for their prebiotic properties related to obesity prevention. The aim of the present research was to investigate the quality attributes of maize tortilla containing 10% (w⁄w) AX or 10% (w⁄v) cross-linked AX. AX were extracted from maize bran and presented an arabinose to xylose ratio of 0.61 and a FA content of 0.54 µg⁄mg polysaccharide. Laccase induced gels of AX at 2% (w⁄v) showed storage (G') and loss (G'') moduli values of 77 and 0.2 Pa, respectively; and a diferulic acid content of 0.20 µg⁄mg AX. The addition of AX and cross-linked AX to maize flour resulted in an increase of water absorption. Tortillas were elaborated and then analyzed for weight, diameter, color, texture, microstructure and sensory attributes. The addition of AX and cross-linked AX did not modify the weight, diameter and color of tortillas significantly; but allows a decrease in hardening, improving texture. Scanning electron microscopy images of tortilla containing cross-linked AX showed a less porous and more homogeneous microstructure in comparison to tortilla with non-cross-linked AX and control. Additionally, maize tortillas containing cross-linked AX present acceptable organoleptic characteristics.

Keywords:
Maize, ferulated arabinoxylans, gels, cereal foods

04 Nutrition and Health

PREBIOTIC EFFECT OF DIGESTED WHOLE GRAIN FLOUR AND ARABINOXYLAN EXTRACT

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Whole grain wheat flour (WWF) has a higher dietary fiber content than refined flour. Arabinoxylans (AX) are part of this dietary fiber and they have received attention given their emergent prebiotic character. The objective of this work was to evaluate the *in vitro* prebiotic effect of a raw WWF, a previously digested WWF and a water-soluble AX extract (WSAX). An *in vitro* flour digestion simulating oral, gastric, and intestinal steps was used to prepare the digested WWF. Arabinose/xylose rate of WSAX extract was determined. Quantitative scores were calculated to describe the extent to which raw WWF, digested WWF, and WSAX extract support selective growth of *Bifidobacterium* and *Lactobacillus* strains in a defined media. Inulin (IN) was included as a positive control. The prebiotic activity (PA) was determined considering the growth ratio relative to the glucose of probiotic strains as well as of the enteric bacteria *Escherichia coli,* when raw WWF, digested WWF or WSAX were used as C source. Moreover, the bacterial growth of *Clostridium* and *Bacteroides* strains were assessed. For prebiotic index (PI), the bacterial growth of *Bifidobacteria, Lactobacilli*, clostridia and bacteroides were entered into the PI equation to determine a quantitative PI score. WSAX extracts promoted a higher relative growth for *Lactobacilli* (PA: WSAS 0,37 vs. IN 0.18) and *Bifidobacteria* (PA: WSAS 0.36 vs. IN 0,28) compared with inulin, which resulted in positive values. Digested WWF showed higher PA for *Bifidobacteria* (PA 3.77) but lower for *Lactobacilli* (PA 0.03) compared with WSAX. No prebiotic activity for raw WWF was found. The PI value for WSAX was higher than the value obtained with commercial IN (4.09 vs. 2.62). Digested WWF presented a very low PI. These results suggest that WSAX extracts could be used as a prebiotic food ingredient, and thus to evaluate their ability to modulate microbiome *in vivo* becomes interesting.

Keywords:
Whole wheat flour, Arabinoxylan, Prebiotic

GLUTEN-FREE LAMINATED BAKED PRODUCTS: UTILIZATION OF ADDITIVES COMBINATIONS TO IMPROVE TECHNOLOGICAL QUALITY

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Currently, a wide spectrum of disorders related to gluten intake has been reported, like celiac disease (CD). The need of people with CD to have safe, affordable and tasty food raises a challenge, particularly for baked products. The aim of this work was to assess the simultaneous effect of xanthan gum (XG), *psyllium* (P) and cyclodextrinase (CGT) on the physical and textural attributes of gluten-free laminated baked products. A 3-factor-5-level Box Behnken model and 15 baking assays were carried out. A central composite design was prepared and the additives levels were 0.05%-0.30%. Quality parameters (height and width relationship, shape factor, firmness, crumb fractal dimension, crust color) were assessed. The regression equations and surface responses for each quality attribute were obtained. The predictive equations were validated applying Multiple Response method and additives combination were determined in order to maximize height, shape factor, fractal dimension and crust lightness and minimize width relationship and firmness. To confirm the predicted values of regression equations baking tests were performed from the optimum additives levels and the quality parameters was analyzed. Higher levels of P and CGT cause a greater increment of the product height during baking. XG and CGT had a positive linear effect on firmness. Higher CGT doses increased the crumb tortuosity, related to a greater level of lamination. While the combination with XG had a quadratic positive effect on fractal dimension. The additives levels necessary to obtain the highest quality laminated product were established as 0.38% XG, 0.10% P and 0.23% CGT. The differences among predictive and experimental values were lower than 15% indicating a good predictive capacity of gluten-free laminated quality attributes.

Keywords:
gluten-free, laminated, technological quality

05 Food Safety

OCCURRENCE OF MYCOTOXINS IN WHEAT AND CHALLENGES WITH SAMPLING AND MEASUREMENT

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Deoxynivalenol (DON) is a mycotoxin found in wheat that is infected with Fusarium fungus. DON may also be converted to a type of “masked mycotoxin”, deoxynivalenol-3-glucoside (D3G), as a result of detoxification of the plant. DON and D3G were measured using gas chromatographic (GC) and liquid chromatography-mass spectrometry (LC-MS) in wheat samples collected during 2011 and 2012 in the USA. Results indicate that the growing region had a significant effect on the DON and D3G ($p < 0.0001$). There was a positive correlation between both methods (GC and LC-MS) used for determination of DON content. DON showed a significant and positive correlation with D3G during 2011. Overall, DON production had an effect on D3G content and kernel damage, and was dependent on environmental conditions during Fusarium infection. The occurrence of mycotoxins in the hard red spring wheat growing region of the United States, as well as in other regions varies widely by crop and growing season. For this reason, it is critical to have reliable systems for grain sampling and accurate testing methods for mycotoxin determination. Growing area, weather conditions, grain storage conditions, sampling area, grain sample size and collection locations can all have a substantial impact on the accuracy of sampling grain for determination of DON. The wide array of mycotoxins and secondary metabolites that have variation in chemical composition also contribute to the challenge of accurately measuring the presence of mycotoxins in wheat. Overall, it is very important to address the challenges related to sampling and measurement of mycotoxins in wheat for the purpose of implementing mitigation strategies.

Keywords:
Mycotoxins, Masked mycotoxins, Occurance, Determination

ZN AND CD CONTENT IN THE GRAIN OF WHEAT: REGION AND GENOTYPE

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For Kazakhstan, the most important production of ecologically pure and high quality grain products. The most ubiquitous pollutants in Kazakhstan are copper, cadmium and zinc. There are different opinions on the effect on the adaptive plant metabolism.

Identification of *Zn*-deficient and *Zn*-excessive regions has been performed using data from different regions for the standard variety - Saratovskaya 29.

Zn content in spring wheat varies across average background from 11-12 mg⁄kg to 41 mg⁄kg. The lowest *Zn* content in the grain was recorded at the three sites: Osakarov, Shortandy (10-13 mg⁄kg) and Kazan GSU (11-22 mg⁄kg), which correlates to drought problems in these regions.

Maximum *Zn* content was recorded in the following sites: Alga, Aytekebi, Ruzaev, Shchuchin, Lenger and Gvardeysky (45-80 mg⁄kg). Background average was recorded at the Ruzaev site. Lenger and Ruzaev sites are characterized by high proportion of genotypes with grain *Zn* content of more than 41 mg⁄kg (50-65% of genotypes).

Aktubinsk region with KASIB spring wheat is characterized as low-level by zinc content, which is reduced to below 12 mg⁄kg, and thus *Zn*-deficient grain. A ranking of regions was established with decreasing *Zn* content in the grain of KASIB spring wheat: Fiton > Karabalyk > Pavlodar > Aktyubinsk.

Zn-deficiency of certain spring wheat growing regions according to wheat data is confirmed by minimum *Zn* content values in barley (for Osakarov at 14-15 mg⁄kg and Urlyutyub, Arykbalyk at 17-19 mg⁄kg).

One of such samples is the wild forms of wheat. Cd content in the grain in reproduction for wild relatives (16 Triticum spices) and Aegilops varies from less 20 to 25 mg⁄kg (*T.persicum* and *T.kiharae*) and in the second reproduction from less 20 mg⁄kg to 24-26mg⁄kg (*T.spelta*, *T.polonicum, T.militinae*) and maximum to 35mg⁄kg among *Triticum* for *T.dicoccum*. Among the 5 samples of *Aegilops* origin only *Ae.cylindrica, Ae.squarossa* was differing with a high Cd content in the grain (30 and 54 mg⁄kg).

Keywords:
wheat, wild relative, Zn and Cd content, ecologicall safety

POTENCIAL OCCURANCE OF PYRROLIZIDINE ALKALOIDS IN WHEAT FLOUR IN SOUTH BRAZIL

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Pyrrolizidine alkaloids (PAs) are natural toxins exclusively biosynthesized by plants from the families of *Asteraceae*, *Boraginaceae* and *Fabaceceae*. The weeds most commonly found in wheat crops in southern Brazil are from the *Asteraceae*, Polygonaceae and Cruciferae families, among them *Senecio brasiliensis*, *Sonchus oleraceus*, *Erigeron bonariensis, Polygonum convolvulus* L. and *Raphanus raphanistrum* L. Of these species, *S*. *brasiliensis*, *S*. *oleraceus*, and *E*. *bonariensis* have been reported as producers of PAs outside Brazil. Large incidents of acute food poisoning with PAs are associated with high mortality, and a subacute or chronic onset may lead to liver cirrhosis. The objective of this research has been to verify the occurrence of PAs in wheat lots from commercial field crops with weed infestations.

A total of 18 wheat crops established at Guarapuava, in the State of Paraná, Brazil, with ineffective control of weeds and presence of mature seeds of weeds at the time of harvest, were selected in 2016 crop. Samples from each crop were collected directly from the truck at the time of loading, following a sampling standard, obtaining 18 samples composed of wheat kernels, weed seeds and impurities. Weed seeds were separated from the wheat kernels. Afterwards, weed seeds were identified, weighed and counted. Seeds of the following species were found: *P. convolvulus* L., *R*. *raphanistrum* L., *Lolium multiflorum* Lam. (rye grass), *Avena sativa* L. (oats) and *Hordeum vulgare* L. (barley). Next the weed seeds were incorporated back into the samples they belonged to. Then, the wheat kernels and weed seeds from each sample were homogenized with a sample splitter, and each sample divided in two. To obtain the patent flour (PF), bran and shorts were separated, as well as germ, wheat kernels representing half the amount from each sample were tempered in order to mellow the kernels to be milled with a laboratory mill. To obtain whole grain flour (WGF), kernels from the remaining amount from each sample were milled with a water-cooled laboratory mill. Validated analytical methods based on liquid-chromatography coupled with tandem mass spectrometry (LC-MS⁄MS) were used to detect and accurately quantify 28 different PAs.

Only one PAs (senecionine-N-oxide) was detected in five out of the 18 wheat crops, whereas others PAs contents were below the level of detection. There were differences in relation to weeds in the contamination of wheat flour with senecionine-N-oxide. The amount of senecionine-N-oxide was higher in the flour with predominance of *R. raphanistrum´*s seeds, when compared to the flour with predominance of other weeds. *R*. *raphanistrum* belongs to the Cruciferae family, which plants are not known as PAs producers. Nevertheless, there were no differences between PF and WGF for senecionine-N-oxide contents.

The main result of this research was the occurrence of PAs in wheat lots of commercial field crops with weed infestations. This research also showed a preliminary result that wheat flours

milled with *R*. *raphanistrum* seeds may have contamination with PAs. As this weed is native to South America, it can be inferred that it has not been reported as a biosynthesis of PAs to date due to this fact. However, due to the small number of samples with *R*. *raphanistrum* seeds, it is not possible to state with statistical certainty that this weed is a source of toxic alkaloids. Given the importance of the problem and in view of the preliminary evidence found, it is suggested to continue this research.

Keywords:
Pyrrolizidine alkaloid, Food contaminants, Risk assessment, Wheat flour

06 Food Security

PARAMETRIC ANALYSIS OF YIELD STABILITY AND AGRONOMIC PERFORMANCE EXOTIC QPM HYBRIDS IN PAKISTAN

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South Asia is one of the regions in Asia where chronic malnutrition affects nearly half of pre-school children. In Pakistan almost 45% of children (< 5 years) are reported to be stunted. To alleviate the problem of malnutrition in Pakistan, nine quality protein maize (QPM) hybrids were introduced from CIMMYT-Colombia and evaluated for yield and agronomic performance across different locations; (I) National Agricultural Research Centre (NARC), Islamabad, (II) Maize and Millets Research Institute (MMRI), Yousafwala, (III) Jullundhur Private Limited (JPL), Arifwala, (IV) Four Brothers Private Limited (4B), Lahore, (V) Tara Crop Science (TCS), Sahiwal and (VI) ICI Pakistan Limited (ICI) Sahiwal, and in different seasons (Spring-2014, Kharif-2014 and Spring-2015). Significant differences in the performance of QPM hybrids were observed across the locations and seasons for different agronomic and yield related traits. Mean comparison for grain yield evidently elaborated the differences in performance of hybrids across the locations. These statistical inferences showed that cross-over interactions were present between hybrids and locations therefore GGE comparison biplot analysis was used as multivariate statistical tool to dissect the genotype × environment interaction. Location, season and hybrids comparison GGE biplots were drawn. JPL, 4B and TCS during spring season were found most productive, representative and discriminating locations whereas MMRI during kharif season was found as least discriminating and low yielding locations for these QPM hybrids. Seasonal comparison showed that spring season is most productive than kharif season for these QPM hybrids. Hybrid comparison showed that 1 (SA2146-38), 3 (SA2146-40), 4 (SA2146-75) and 2 (SA2146-39) hybrids were highly productive across the locations and across the seasons therefore commercialization of these QPM hybrids is recommended in Pakistan to combat malnutrition through direct and indirect consumption of QPM.

Keywords:
Malnutrition, GGE biplot, grain yield, agronomic traits, QPM

07 Recent Developments in Breeding & Agronomy

BREEDING FOR FUSARIUM MYCOTOXIN RESISTANT WHEAT GERMPLASM AT CIMMYT, MEXICO

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Fusarium head blight (FHB) is a major wheat disease globally. In addition to yield reduction, greater concern is due to the contamination of mycotoxins, represented by deoxynivalenol (DON), which is harmful to both human and animals. Although DON reduction is the final goal for FHB resistance breeding at CIMMYT, screening for DON concentration for all breeding lines is not realistic due to high costs. Moreover, field FHB severity usually shows significant positive correlation with DON content. Therefore, we first conduct field FHB screening since the beginning of FHB/DON research and breeding resistant wheat germplasm in the 1980s. The major activities include screening advanced breeding materials developed at CIMMYT, evaluating exotic resistance sources and germplasm bank collections for their potential use in breeding programs, and performing genetic studies to decipher resistance mechanism and develop molecular markers to be used in marker-assisted selection (MAS) (1). Selection for FHB resistant germplasm is based on multiple-year (usually three consecutive years in field) data of field FHB index, a confirmative experiment in greenhouse, Fusarium damaged kernels, DON concentration, and phenological traits heading and height. Pedigree information is also considered for maintaining genetic diversity of the nursery. Promising lines with low FHB parameters and good agronomic traits are included in FHB screening nurseries (FHBSN), which are prepared and distributed to National partners globally. The inclusion of DON test for promising lines guarantees that all selected lines have low DON content. Haplotyping allows testing for the presence of known FHB QTLs in breeding materials, and several resistance genes/QTLs have been included in our haplotyping system (1, 2). Recent breeding and research priorities include the utilization of *Fhb1/Sr2* recombinants, deployment of a major QTL on 2DLc for both FHB and DON, and characterization of a major QTL on 3DL that is associated exclusively with DON reduction.

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Keywords:

Mycotoxin, Fusarium head blight, Disease resistance breeding, Wheat

IDENTIFICATION AND DEVELOPMENT OF HEALTHY BARLEY GENOTYPES TOLERANT TO ABIOTIC STRESS FACTORS

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The major dietary fiber (DF) components in barley grain are the cell wall polysaccharides, β-glucan and arabinoxylan (AX), which account for about 75% and 20%, respectively, of the total cell wall polysaccharides in the endosperm. β-glucan occur in soluble and insoluble forms (in 50-50%), which may differ in their health benefits. Insoluble DF lowers transit time and increases fecal bulk and binding of carcinogens, while soluble DF reduces the risk of coronary heart disease and type II diabetes. DF components, also affect the processing properties of wheat, for example, the quality for livestock feed or the fermentation to produce.

Sixty international barley genotypes and sixty breeding lines were tested for test weight, thousand kernel weight (TKW), protein (Kjeldahl) and β-glucan (Megazyme) content.

Five genotypes were identified with high test weight (71-77 g⁄100L) and seven with high TKW (51-55 g). Five genotypes were found to be good resource of high β-glucan content (57-68 mg⁄g) and seven of high protein (15.0-17.5%), being promising stocks for food or feed uses. Low β-glucan (32-36%) and low protein (11.7-12.6%), genotypes were also identified for processing purposes. New crossing programs were started with these genotypes and existing breeding lines were also tested among which four breeding lines were identified with high β-glucan content (57.2-64.2mg⁄g). Selected genotypes were planted and tested for drought tolerance as well.

Results will contribute to the development of barley genotypes for animal feed, healthier human consumption and⁄or better processing quality while the plants having better drought tolerance.

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Keywords:
barley, breeding, β-glucan

GRAIN BIOCHEMICAL CONTENT OF WHEAT WILD RELATIVES FOR BREEDING DEVELOPMENT

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The wild relatives as sources for the introgression of genetic material in breeding transitional forms on the content of protein and protein fractions (albumin + globuline; gliadine, glutenine, residual (insoluble), of starch, amylose and β-glucane was studied.

Grain protein content was formed by the prevalence of various protein fractions: 1) globulin for *Ae.triaristata* grain (40.6% of total) and *T.militinae* (35,7%); 2) gliadin *for T.kiharae* (38,9-40,5%); *T.timopheevi* (33,7-36,6%); *T.dicoccum* (34,5-36,4%); 3) high level insoluble protein (8,1-11,9%) was found for *T.spelta* and *T.shaerococcum* and minimal (2,3-3,2%) for *T.timopheevi*, *T.dicoccum*, *T.militinae* and *T.kiharae; 4)Aegilops* characteristic of residual protein was at the level 7-8%. The content of S, as an essential element in the formation of protein globules was deficit according to the ratio of N: S except *T.timopheevi*, *T.compactum*, *T.turgidum*, *T.aethiopicum*. Grain amylose content varied from 18.8% (*T.petropavlovskyi*) to 31.5% (*T.timopheevi*).

The maximum content of β-glucan is characteristic of *Ae.triaristata* and *Ae.cylindrica*, then *T.dicoccoides* and *T.macha*. Consistently high content of β-glucan noted for *T.shaerococcum* and *T.timopheevi*. Stable minimum content of β-glucan differed *T.militinae*.

Wild relatives of wheat were characterized by a sufficient amount of gluten proteins. The gluten (ISO) content was 21.2% for *T.dicoccoides* to 39,0% for *Ae.triaristata*. Thus gluten quality varied within a group II-III as 90 units gluten deformation index (GDI) (*T.spharococcum,T.macha, T.polonicum, T.dicoccoides*) and 100 units GDI for *T.militinae* to low quality - 115 units GDI for most spices.

Using cluster analysis of gliadin electrophoresis spectrum we classified wild relatives. The most remote of all were*T.monococcum* and *T.ispanicae*. Distribution of species into 3 clusters was determined by 1) the absence of α-gliadin component for *Aegilops*, 2) absence ω9 - gliadine or ω89 – gliadin for tetraploid wheat and *T.compactum* (A^bGD), 3) presence of gliadin components specific to *T.kiharae* and *Ae.cylindrica* in ω-zone; to *T.militinae* and *T.timopheevi* in α-gliadin zone. Identification of synthetic wheat by SSR-markers Xgwm312, Xgwm135 and Xgwm304, respectively enabled to detect between 2-7 alleles per locus that allows to certify DNA genotypes for further use in the breeding.

Keywords:
species, protein, amylose, gluten

PHOTOSYNTHETIC HETEROSIS PERFORMANCES IN 2 HYBRIDS WHEAT

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Two hybrid wheat, Hengza 102 and Hengza 1508, and both corresponding parents and check cultivar were involved. Marked the flag leaves unfolding completely at the same day, and measured the photosynthetic parameters of all varieties every 7 days from 1st-36th d. The parameters included photosynthetic rate (P_n), stomatal conductance (g_s), mesophyll conductance (g_m), chlorophyll content (CHL), relative steady phase of chlorophyll content (RSP), photosynthetic active duration (PAD), leaf source capacity (LSC) and heterosis. For the heterosis was described by mid-parent (MH) one and over-standard (OH) one.

The results suggested that: the P_n were increasing first and then decreasing for all varieties during 1st-36th d, and reached the maximum at 7th d. Compared with CK, the P_n of Hengza 102 and Hengza 1508 were lower during 1st-15th d, were higher and increased during 22th-36th d. The OH of 2 hybrid wheat reached the maximum at 36th d, were 8.2% and 8.5%. During 1st -15th d, the P_n of Hengza 102 was in the middle of its parents' P_n, while the P_n of Hengza 1508 was higher than its parents, and both were higher than their corresponding parents and increased gradually during 22th-36th d. The MH of t 2 hybrid wheat reached the maximum at 36th d, were 23.2% and 25.8%.

The g_s of all varieties reached the maximum at 1st d, and decreased gradually during 1st-36th d. The g_s of Hengza 102 and Hengza 1508 were higher than their corresponding parents and CK. The MH and OH of 2 hybrid wheat increased gradually during 1st-36th d, and reached the maximum 20.6%, 13.5% and 20.4%, 15.3% at 36th d. The high g_s of 2 hybrid wheat might be connected with their stoma number, size, structure and distribution etc. which were superior to their corresponding parents and CK.

The g_m changing trend of all varieties were similar to g_s, but the declining rate was faster than g_s during 15^{th}-36^{th} d. During 1^{st}-15^{th} d, the g_m of Hengza 102 was in the middle of its parents' g_m and lower than CK, and the g_m of Hengza 1508 was higher than the parents and lower than CK. While during 22^{th}-36^{th} d, the g_m of 2 hybrids were higher than their corresponding parents and CK. The MH and OH of t 2 hybrid wheat reached the maximum at 36 d, were 16.2%, 7.4% and 21.8%, 6.5% respectively.

The RSP, PAD and LSC of Hengza 102 and Hengza 1508 were all obviously higher than their corresponding parents and CK. It indicated that the photosynthetic functional period of hybrid wheat flag leaf was longer than their corresponding parent and CK, and the photosynthetic carbon assimilation capacity of hybrid wheat flag leaf was enhanced. The P_{nmax} was in the middle of its parents' P_{nmax} and lower than CK for Hengza 102, but the P_{nmax} was higher than its parents and CK for Hengza 1508. The results showed that the heterosis of 2 hybrid wheat was different at the highest photosynthetic rate, and the heterosis of Hengza 102 was lower than Hengza 1508.LSC and RSP, LSC and PAD were significantly related, but the relation of LSC and P_{nmax} were distinct in different hybrids and performed lower for Hengza 102 and significantly higher for Hengza 1508.It was concluded that the difference of formation mechanism of LSC in different hybrids, LSC heterosis of Hengza 102 was due to the advantages of prolonging the functional period of leaf photosynthetic, but for Hengza 1508 LSC scale advantage was derived from prolonging its photosynthetic function period and increasing its photosynthetic rate. In order to get a higher yield it should be should strengthen the later stage management and fully exploring LSC heterosis in production.

Keywords:
Hybrid wheat; Photosynthetic rate; Physiological parameters; Heterosis; Flag leaf;

DETECTION OF QTL FOR QUALITY TRAITS USING A BREAD WHEAT NESTED ASSOCIATION MAPPING (NAM) POPULATION

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In the last century wheat breeding programs have shown a consistent increase in grain yield associated with lower concentration of protein in grain. A better understanding of the genetic basis of the negative correlation between grain yield and protein content would be valuable for breeding purposes. In this work a NAM population was developed using a set of spring wheat genotypes for genetic dissection of grain yield and quality. Blanca Fuerte (high yield and low protein) was used as recurrent parent against eleven cultivars and advanced lines from CIMMYT and UC Davis (medium-high yield and protein) to develop 372 RILs. The population was genotyped with 90K SNP chip and a linkage joint map was constructed including 4501 polymorphic SNPs distributed in 970 loci along the 21 wheat chromosomes. The population was phenotyped in Davis (California, USA) in 2012 and 2013, and Marcos Juárez (Córdoba, Argentina) in 2014 and 2015. Four agronomic traits were evaluated: Yield (YLD), Thousand Kernel Weight (TKW), Test Weight (TW) and Grain Protein Content (PROT). We prioritized QTLs that were detected in the same location for two consecutive years or in three of the four environments evaluated. Based on these criteria, we identified 4 QTL for PROT, 2 for TKW and 2 for TW. For grain yield, QTLs were detected but were not stable. Lack of collocation among main QTLs for PROT with TWK, TW and YLD positionate detected PROT QTLs as good candidates for protein selection without penalizing YLD.

Keywords:
Wheat, QTL, Protein, Yield.

THE WATKINS COLLECTION AS A SOURCE FOR GENETICALLY VERSATILE PRE-BREEDING LINES FOR NUTRIENT USE EFFICIENCY

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Landraces are a great source of variation for the discovery and dissection of important traits and to develop pre-breeding lines. The Watkins collection comprises of phenotypically diverse landraces collected in the 1920s and 1930s from 32 countries, including India. We are utilising this diversity to investigate nutrient use efficiency (NUE) within INEW, a NewtonBhabha funded programme with six partner institutes in India and five organisations in the UK. Replicated field trails are essential to dissect biological NUE and to develop germplasm for pre-breeding, one of the main objectives of the INEW VJC. To put the "J" into the Virtual Joint Centre it is important that all the partners are using similar and related material. However, the field locations could not be more diverse, from irrigated trials at Pusa (25° 59' N) to rainfed fields in Nottingham (52° 82' N), requiring material adapted for very different environments. Early flowering material is needed for India to escape the heat and drought stress during grain filling whereas late flowering material can escape cold early in the UK season. A nested association mapping panel using 85 founders with Paragon (UK spring) as the common parent has been established at the JIC within the BBSRC WISP project. Families were selected that showed promising NUE traits in the UK and adapted subgroups of these families were chosen for field trialling in India and the UK.

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Keywords:
Nitrogen Use Efficiency, landraces, Watkins, adaptation

INVESTIGATION THE VARIABILITY OF ARABINOXYLANS IN WHEAT VARIETIES AND BREEDING LINES

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Arabinoxylans (AXs) are one of the major dietary fiber components of wheat. Nutritional facts show that the cereal dietary fiber and AX consumption has effect on the digestibility and adsorption of food components, and is inversely related to the obesity, diabetes, certain types of cancer and cardiovascular diseases. Beside the nutritional value, arabinoxylans have impact on the technologically important properties of the dough and cereal based food products. Water-extractable arabinoxylans enhance the water absorption and viscosity, and increase the bread volume while water-unextractable arabinoxylans can increase the water absorption as well and improve the shelf-life. It may be desirable to breed lines and varieties which have more from these components. There is not enough information about the genetic and environmental variability of the content and the composition of non-starch polysaccharides. In addition, the complex effect of composition change on the technological behaviour is also less explored. The goal of our research is to investigate different Hungarian wheat varieties and breeding lines from three years harvested in Martonvásár in order to explore the effects of genetic factors and year of harvest on the quantity and composition of AX. Our results show that the AX content and partly the composition is mainly depending on the genetic factors, while environment play a minor, but not negligible role in the formation of AX content and pattern. These facts confirm the legitimacy of the AX-orientated breeding research.

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Keywords:
dietary fiber, arabinoxylan, wheat, GxE variability

HOW BIOTROPHIC AND NECROTROPHIC PATHOGENS AFFECT THE DYNAMICS OF NITROGEN IN WHEAT?

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Accumulation and redistribution of nitrogen (N) are important processes determining grain yield and grain quality in wheat (*Triticum aestivum* L.) and could be affected by foliar fungal pathogens like leaf rust (*Puccinia triticina* Eriks) and tan spot [*Pyrenophora tritici-repentis* (Died.) Drechs., anamorph *Drechslera tritici-repentis*) (Died.) Shoem.], main biotic threats that affect wheat production in Argentina and many production areas in the world. Although effects of foliar diseases on N dynamics have already been studied based on an ecophysiological approach, none of these studies analyzed the independent effects of foliar pathogens with different nutritional habits in field conditions. The present study was designed to determine the effects of independent artificial inoculations of foliar diseases with different nutritional habit 1) *Py. tritici-repentis* (necrotroph) and 2) *P. triticina* (biotroph) on the green leaf area index dynamics, N remobilization, N post-anthesis absorption,% N in grains and N stored in grains in bread wheat crops. Field experiments were carried out during two consecutive years combining a large range of wheat bread commercial cultivars and two levels of inoculation to promote infection of tan spot and leaf rust diseases, including a control without inoculation. Treatments were arranged in an experimental split-split plot design with three replications, where the main plots were both diseases, subplots corresponded to inoculation treatments 1- Without inoculation, 2- Low concentration of inoculum of each disease, 3- High concentration of inoculum of each disease, and ten Argentinean bread wheat commercial cultivars were the sub-subplots. The area under the percentage of non-green leaf area, healthy area duration, green leaf area index, aboveground biomass and parameters associated with N dynamics: N remobilization (NREM), N post-anthesis absorption (NPA), %N in grains (%NG), N stored in grains (NG), N remobilization efficiency (NRE) and N harvest index (NHI) were calculated. Regarding the crop N dynamics, the results indicate that the mode of nutrition of the pathogens would cause a differential effect in these variables with more noticeable effects on *P.triticina*, a mechanism that would be explained by the retention of N in green tissues and pustules of this biotrophic pathogen, which prevents the normal translocation of N to the grains due to reductions on NRE and NHI. In this sense, inoculations with *Py.tritici-repentis* caused increases in the %NG up to 14.9%, while *P.triticina* caused the inverse effect, reducing this variable by 9.89% with respect to the non-inoculated treatment. Both, NREM (-30.9%) and NG (-24.4%) showed higher reductions under increases in the inoculum dose of *P.triticina*, while no significant reductions were detected under *Py.tritici-repentis* infections. Results of this work addressing how pathogens as *Py. tritici-repentis* and *P. triticina* affect N dynamics could be

useful to improve the quantification and modelling of yield and quality losses and predict the disease´s effects more accurately and robustly than those models that only consider a phytopathological perspective.

Keywords:
N remobilization, N post-anthesis absorption, foliar fungal diseases, N stored in grains

VARIABILITY FOR CROWN RUST RESISTANCE, GRAIN YIELD AND GRAIN QUALITY IN ARGENTINEAN OAT GENOTYPES

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Oat (*Avena sativa* L.) is a cereal crop used worldwide for human food and animal feed. It has been studied most often due to its multifunctional characteristics and nutritional profile. Furthermore, crown rust, caused by *Puccinia coronata* Corda, is the most important disease affecting this crop in Argentina, causing losses in grain yield and grain quality, which affects negatively the industrialization and commercialization of oat grain. The objective of this study was to evaluate several characteristics of agronomic importance such as resistance to crown rust, yield and grain quality in oat lines from the breeding program of Cereals, National University of La Plata (UNLP) in relation to commercial cultivars, in order to register those lines as cultivars at the Instituto Nacional de Semillas (INASE). Experiments were carried out at the Experimental Station J. Hirschhorn, Los Hornos, during 2014 and 2015, with 20 oat genotypes (13 commercial cultivars and 7 advanced breeding lines from the UNLP program) in an randomized block design with three replications. Resistance to crown rust in the field was evaluated as the severity caused by the disease at the flag leaf stage, anthesis, dough stage, and the area under disease progress curve (AUDPC) was calculated. In addition, the grain yield, its components and several parameters of grain quality were evaluated. Results indicate that the lines L1, L2, L5, L6 and the commercial cultivars Canaí and Maxima showed the highest resistance to crown rust in the field in both years. L2, L5 and Canaí stood out in both years for grain yield, thousand kernel weight, test weight, oat groat size and oat grain size, whereas L2, L1, L6, L4, L3 and Violeta had the highest protein percentage and in general all the lines belonging to the Cereals breeding program stood out for ease of shelling. The AUDPC was negatively associated ($p < 0.05$) with thousand kernel weight ($r=-0.66$), test weight ($r=-0.80$), yield ($r=-0.63$) and caryopsis percentage ($r=-0.37$). Outstanding oat lines for several traits were found.

Keywords:
Oat, crown rust resistance, grain yield, grain quality

GLOBAL NETWORKING FOR PRECISION WHEAT PHENOTYPING

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Global research collaboration strategies are being developed to further enhance wheat yields and ensure food safety and security. Based on a global network of wheat partners, several precision field-based wheat phenotyping platforms (PWPP) have been developed with the support of the CGIAR Research Program on Wheat and co-investing national agricultural research institutes. The selected locations represent key environments for the generation of precision phenotypic data on prioritized traits, under defined good practices, and fostering global germplasm exchange among participating NARS and scientists. Although research currently focus on particular traits evaluated at hotspots for these specific diseases and⁄or future-climate analogue sites, this model opens opportunities to increase coordination in wheat phenotyping, avoiding duplication of efforts and building on efficiency and capacity for research. It is expected that better-coordinated and more standardized phenotyping accelerates genetic gains, contributing to secure the superior germplasm development and the dissemination of higher yielding, appropriate processing⁄end-use characteristics, and stress resistant wheat lines to farmer fields.

Keywords:
Networking, wheat phenotyping

THE SOUTH AFRICAN NATIONAL WHEAT BREEDING PLATFORM

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During 2014 the South African National Wheat Breeding Platform (SA-NWBP) was established by the Grain Research and Policy Centre of Grain South Africa. The SA-NWBP includes Stellenbosch University's Plant Breeding Laboratory's (SU-PBL) wheat pre-breeding programme, primary research partner, and since 2017 also that of the Agricultural Research Council's Small Grains (ARC-SG) pre-breeding group. The initiative also includes local breeding programmes from the public, ARC-SG, and private sector, PANNAR and Sensako. The primary aim of the SA-NWBP is to achieve a sustainable increase in wheat productivity for grain producers. Pre-breeding is one of the most effective ways to introduce existing and⁄or novel genes and traits into breeding programmes, and therefore vital to improve genetic resources to ultimately obtain better, more productive cultivars. The SU-PBL's efforts as part of the SA-NWBP builds on its already established wheat pre-breeding research programme, and consists seven workpackages (WP): WP 1. Stakeholder engagement; WP 2. Germplasm gathering and preliminary phenotypic screening; WP 3. Male sterility mediated marker assisted recurrent selection (MS-MARS) facilitated crossing programme; WP 4. Molecular marker identification, optimization and implementation; WP 5. High throughput phenotyping; WP 6. Capacity building; and WP 7: Seed multiplication and distribution. As part of WP 7 during 2017 an annual nursery was already distributed and consisted out of 295 lines that could either be hand-sown (1 package of seed consisting15g) or planted as yield plots (4 packages of 100g). According to a survey among the recipient breeding programmes on average 44 selections were made, and included as either direct introductions and⁄or crossing parents.

Keywords:
Pre-breeding, Germplasm, MS-MARS

DEVELOPMENT OF SUITABLE RICE VARIETIES FOR DROUGHT AND SUBMERGENCE PRONE AREAS OF NEPAL

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Rice, a major cereal crop of Nepal, occupies an area of 1.48 million hectares with a total annual production and productivity of 4.95 million ton and 3.34 t⁄ha, respectively. In Nepal, rice is cultivated in diverse ecosystems such as irrigated (51%) and rainfed lowland ecosystem (49%). The yield of rice is very low in the country especially in rainfed lowland production ecosystem. Submergence and drought often affects the rice crop in rainfed areas. Farmers usually re-transplant after receding of flood water from rice fields and such fields are also affected with terminal drought at reproductive stage of crop because of early cessation of rainfall. In Nepal, about 30% of the total rice area is prone to drought and about 15% area is often prone to flash flood. So, increase productivity per unit area under unfavorable environment will significantly help to increase rice production in the country. Undoubtedly, rainfed rice farming has high demand among rice growers in the country. The Sub1 gene was identified in a rice genotype (FR13A) which is highly resistant to flash floods and proved to be the major determining gene for submergence. Swarna Sub1 was developed by transferring Sub1 gene in Swarna, a mega rice variety and was released in 2011 in Nepal. Though, Swarna Sub1 is tolerant to submergence; the variety is sensitive to drought at reproductive stage. Therefore, multi-trait crossing was set up to develop a genotype tolerant to drought and submergence for rainfed lowland areas. Drought tolerant quantitative trait loci were introgressed in Swarna Sub1 to generate submergence and drought tolerant rice genotypes. Developing drought and submergence tolerant varieties is the most promising approach to tackle both submergence and drought stresses in rainfed conditions. Keeping these points in view, National Rice Research Program, Hardinath, Nepal in collaboration with International Rice Research Program, Philippines, three drought quantitative trait loci (QTL 1.1, QTL 2.2 and QTL 3.1) and Sub1 gene introgressed breeding lines were evaluated in various trials viz., advanced yield trials, coordinated varietal trials, coordinated farmer's field trials and participatory varietal selection trials from 2012 to 2015. Of the tested genotypes, IR 94391-131-358-B-1-1-1 and IR 96321-1447-651-B-1-1-2 performed better for grain yield, survival percentage under stress conditions and maturity periods. Based on the multi-location trials, IR 94391-131-358-B-1-1-1 and IR 96321-1447-651-B-1-1-2 were found better and were well adopted in partial irrigated and rainfed conditions in many districts of the country. Majority of farmers preferred IR 94391-131-358-B-1-1-1 and IR 96321-1447-651-B-1-1-2 for higher grain yield with submergence and drought tolerant and also for suitability in different cropping systems. These two genotypes also possessed field resistant to major rice diseases and pests. The grain yield of IR 94391-131-358-B-1-1-1 and IR 96321-1447-651-B-1-1-2 were 5.5 and 5.8 t ha-1 with maturity period of 138 and 145 days, respectively. These varieties could be options for Samba masuli, Swarna, Swarna Sub1 and Sabitri in rainfed lowland areas where flash flood and drought occur alone or

together commonly in the same season. Considering the importance of these two genotypes under changing climatic context to address the issue of drought and submergence stresses, the National Seed Board of Nepal recently released these two genotypes, IR 94391-131-358-B-1-1-1 and IR 96321-1447-651-B-1-1-2 by the name of Bahugunidhan-1 and Bahugunidhan-2, respectively for commercial cultivation in terai, river basin and valley up to 700 masl agro-ecological zones in Nepal. The varieties are becoming popular and are expanding in wider areas in rainfed and irrigated areas where flash flood and drought are threat to rice production in the country.

Keywords:
drought and submergence tolerant rice, Nepal, Popular, Rainfed lowland

DEVELOPMENT OF HIGH PROTEIN AND HIGH OIL SYNTHETIC MAIZE SOURCE MATERIALS

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Corn protein and oil are crucial both human and animal nutritions. Maize oil is high in energy value for livestock feeding and is a valuable by-product of the starch industry. Protein is necessary constituent of both food and feed. High protein and oil corn varieties should be developed for meet the needs. This research was conducted in order to develop synthetic source material for hybrid corn breeding researches.

Kernel protein, oil and starch content was determined on 56 inbred lines using the classical method and this lines used as a starting material. Six inbred lines with a high oil content (5-6%) were made to half diallel crosses. Seven inbred lines with high protein content (15.04 to 17.09%) were still made half diallel crosses. Diallel hybrids were planted according to a randomized complete block experimental design in 2010. Half diallel hybrids were evaluated considering grain moisture, yield and some morphological characteristics, protein, oil, and starch content in kernel at harvest.

Initial population was created with half diallel crosses which were selected of considering to grain quality and yield values based on their performance in 2011. This material was applied to a cycle of breeding population. Each family of protein and oil synthetic populations were established to progeny yield trials in 2013. Selected high protein families have got ranged from 12.1 to 15.8% of the protein content. Selected high oil families have got ranged from 5.94 to 7.53% of the oil content.

First cycle of population breeding was completed to recombination of selected families. ADAHPSYN S1 (C1) and ADAHOSYN S1 (C1) was improved. The synthetic populations were used as donor for obtaining DH lines with high oil and high protein.

Keywords:
maize, quality, synthetic population, protein rate

08 Food Legumes

VARIATION OF PHYSICAL AND DYNAMIC OSCILLATORY SHEAR PROPERTIES OF GLUTEN FREE RED KIDNEY BEAN CAKE BATTER AND CAKE WITH RICE

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Red kidney beans (RKB) flour is a potential nutrient rich ingredient and its use has not been fully exploited. The objective of this study was to develop a functional RKB gluten free cake as an alternative to new customers searching for novel ingredients and experiences for healthy customers and celiac disease patients. Dynamic oscillatory frequency sweep (0.1 to 10 Hz at 0.5% strain) and temperature ramp tests (25°C to 95°C with a temperature ramp of 5°C/min) of gluten free RKB cake batter were performed on formulations with addition of rice flour (0%, 6%, 11%, 15%, 25%, based on RKB flour). Non-isothermal kinetic modeling from rheological data showed an insight of changes in gelatinization process in RKB batter after rice addition. Principal component analysis (PCA) evaluated correlation of batter and cake characteristics. RKB cake batter had elastic-like behavior with and without rice addition as revealed by both dynamic oscillatory shear tests. Initiation of gelatinization across all treatments was around 50-55°C. Complex shear modulus, activation energy and tan delta explained 67.1% of the variance (first coordinate axis) of the batter and cake systems studied. RKB cake batter with 25% rice addition increases complex shear modulus (94%) and activation energy (44%) compared to control. Thus, rice flour addition increased structural hardening and activation energy of gelation of RKB batter during heating. Cake hardness was positively correlated with batter viscosity and inflection of gelation temperature. Overall, 25% addition of rice flour to RKB batter decreases cake hardness, batter consistency and inflection temperature. This study describes an improvement of RKB batter and cake macrostructural characteristics with rice addition.

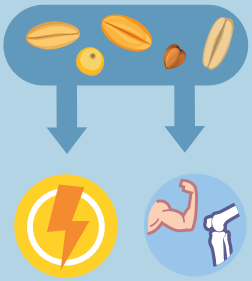
Keywords:
Dynamic oscillatory shear test, gluten free cake, red kidney bean, rice flour

Carbohydrates, Grains and Wheat in Nutrition & Health

Cereal grains and Carbohydrates have been central components of human diets since the beginning of agriculture due to several factors:

1. They are reliable, storable, sustainable, and readily available sources of energy and nutrients

2. As a ready source of energy grains and other staples spare proteins



3. Grains are embedded in a variety of cultural, religious and linguistic traditions around the globe

Cereal grains and other sources of carbohydrates form the nutritional base that sustains life and are associated with other dietary components that allow an optimal health and well-being of the human population.

Dietary Fiber Functions

Dietary fiber

is a class of diverse molecules that are neither digested nor absorbed in the small intestine

and are at least partially fermented in the large intestine

and have benefical physiological effects

- Reduced blood total and/or LDL cholesterol levels
- Attenuation of postprandial glycemia/insulinemia
- Reduced blood pressure
- Increased fecal/bulk laxation
- Decreased transit time
- Increased colonic fermentation/short -chain fatty acid (SCFA) production
- Positive modulation of colonic microflora
- Weight loss/reduction in adiposity
- Increased saciety

Information provided by Grupo Bimbo

Julie M. Jones, Roberto J. Peña, Renee Koczak, and Hans J. Braun . (2015). Carbohydrates, Grains, and Wheat in Nutrition and Health: An Overview Part 1. Role of Carbohydrates in Health. CIMMYT Series on Carbohydrates, Wheat, Grains, and Health, 60 No. 5, 224-233.

The International Association for Cereal Science and Technology is the pre-eminent international association in the field of cereal science and technology, committed to international cooperation through the dissemination of knowledge, conducting research, and developing standard methods that contribute to advance innovation, improve food quality, food safety and food security for the health and well-being of all people. For more information, visit https://www.icc.or.at/.

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