

# NZIFST Annual Conference Poster Abstracts

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# S1

## Bayesian growth model for Shiga Toxin-producing *Escherichia coli* (STEC) in post-slaughter chilling and freezing during beef processing.

Authors: Soundarya Karamcheti<sup>1,2</sup>, Gale Brightwell<sup>2</sup>, Matthew Schofield<sup>1</sup>, Phil Bremer<sup>1</sup>

As ruminants can be asymptomatic carriers of pathogenic Shiga Toxin-producing *Escherichia coli* (STEC), it is important to be able to accurately predict the potential increase in STEC numbers on boned beef during post-slaughter processing. The calculation of microbial growth rate, however, is complicated by the fact that the temperature of the environment (meat) that the bacteria are subjected to is continuously changing from 35°C to -12°C as the whole carcass is processed into portions, chilled and then frozen. In addition, the pH of the meat also changes post-mortem and like temperature, pH can also impact on microbial growth rate. In the current study STEC (O157: H7, O26, and O103) cells were inoculated onto the surface of 1-hour post-mortem beef striploin and the numbers of cells were subsequently estimated over 24-50 hours as the meat was subjected to temperature (37°C to 5°C) changes which simulated hot, warm or cold boning temperature profiles. Meat colour and pH was also assessed over the same time period. Bayesian statistics, with the advantage of being able to account for uncertainty and variability, was used to improve the accuracy of the complex modelling required to predict microbial numbers under dynamic (temperature and pH). The ability to better predict the growth of STEC will enable better informed risk management strategies around post-slaughter meat processing.

- Core finding: STEC growth reached stationary phase within 10 hours of processing profiles.
- Core finding: High variability in growth data observed between E. coli O157: H7, O26, and O103
- Industrial relevance: Accurate, tailor-made, beef model to predict microbial growth during beef processing

Affiliations: 1. University of Otago, 2. Hopkirk Research Institute, AgResearch



# S2

## Can Pulsed Electric Fields technology mitigate the symptoms of Zebra Chip disease in processed potato tubers?

Authors: **Jess Fitzgerald**, Sze Ying Leong, David Burritt, Indrawati Oey

Bacterial pathogen *Candidatus Liberibacter solanacearum* (CLso) is the causal agent of Zebra chip disease (ZC) which has a significant impact on the potato industry in New Zealand. CLso is spread between host plants by an insect vector, the tomato potato psyllid. The insect vector breeds in warmer weather and due to the vector's rapid lifecycle and high fecundity, populations can increase swiftly and result in rapid spread of the disease during the growing season. When infected potato tubers are fried, they produce dark brown colouration in patterns which can vary depending on the severity of infection and cultivar. The cause of the browning has been reported in the literature to be due to increased levels of reducing sugars reacting with specific amino acids, which are the main precursors of the Maillard reaction during frying. ZC results in potato tubers that have limited use for both the fresh market and for processing, and millions of tonnes of infected potatoes are disposed of each year, contributing to resource and food waste. Pulsed electric fields (PEF) is a non-thermal processing technique that has been shown to enhance the leaching of glucose from plant tissues. Using this technology for New Zealand potato cultivars infected with ZC, could lessen the symptoms after frying by lowering the levels of the precursors and thus the rate of the Maillard reaction; therefore reducing the intensity of browning during frying.

- Hypothesis: PEF could enhance the leaching of glucose hence lowering its level
- Hypothesis: PEF has a potential to reduce the symptoms of ZC infection during potato frying
- Industrial relevance: Reducing economic/ industry loss and reducing food waste

Affiliations: University of Otago



# S3

## Kinetics of cathepsin activation and deactivation during *sous vide* cooking.

Authors: Noorul Faridatul Akmal, Michael Parker, John Bronlund, Lovedeep Kaur, Carolina Realini

Naturally present cathepsins have been associated with meat tenderisation during low temperature long time cooking (*sous vide*). Here we study the kinetics of cathepsin activation and deactivation at temperatures of interest during *sous vide* cooking. Thin slices of beef *pectoralis profundus* were vacuum packed and *sous vide* cooked at 46 to 60 °C for times ranging from 0 to 18 hours. Samples were rapidly submerged into ice to arrest the reactions. Cathepsin B and L activity assays were then performed at 37°C on the sarcoplasmic extract. The result shows that cathepsin was easily be activated after heating at 5 min at temperatures between 46 and 50 °C and reached a maximum value after 80 to 100 min. While *sous vide* at temperature 46 to 50 °C for 80 min produces comparable cathepsin activation, cathepsin deactivation was found to be very temperature dependent. The rate of deactivation was very high at 50°C with almost 50% of reduction after 10 hours of heating while only 10% reduction was observed at 46 °C. This study will help to guide the appropriate temperature and time combination selection to maximise the use of native enzymes during *sous vide* processing to enable the tenderisation of meat cuts.

- Core finding: Maximum cathepsin activity can be reached after 80 to 100 min *sous vide* at temperature between 46 and 50 °C.
- Core finding: Cathepsin deactivation was found to be very temperature dependent. The rate of deactivation was very high at 50°C C with almost 50% of reduction after 10 hours of heating while only 10% reduction was observed at 46 °C
- Industrial relevance: This study will help to guide the appropriate temperature and time combination selection to maximise the use of native enzymes during *sous vide* processing to enable the tenderisation of meat cuts.

Affiliations: Massey University, Palmerston North



# S4

## On De-bottlenecking the Limiting Drying Rate and Energy Cost of Atmospheric Freeze Drying

Authors: **Merit Mathew**, **Qun Chen**, Jim R. Jones, Richard H. Archer

Atmospheric freeze drying (AFD) can be a cost-effective alternative to vacuum freeze drying (VFD). It is a superior process for some products, but the slow drying rate limits industrial-scale adoption. As part of the FIET research programme, we are studying the rate-controlling mechanisms in AFD and how rate is affected by the structure of the fruit or leaf. Such understanding will help identify bottlenecks in the process and inform remedies. A mathematical model will help end users run simulations of AFD for different products to find optimal drying strategies. Hops are being used as the first model specimen. Hop cone characteristics will be used to estimate model parameters. Validation will be carried out with an experimental apparatus developed to measure continuous weight loss of food materials as a function of atmospheric freeze-drying temperature.

Our team has also developed a desiccant-dehumidification-driven AFD process for food drying. A prototype of 12 kg daily water removal capacity has been constructed for proof-of-concept. A series of open-cycle drying tests show that the dryer is less expensive to operate than VFD in both capital and energy costs. The prototype, when operating in a closed-cycle mode, can further reduce the energy consumption and reveal the potential to operate under oxygen-depleted conditions. This unit is available for trials.

- Core finding: An apparatus was built to measure continuous in-situ weight loss of food materials.
- Core finding: The AFD prototype in a closed-cycle mode could further reduce energy consumption.
- Industrial relevance: This enables the food industry to have low cost dryers for value-added products.

Affiliations: School of Food and Advanced Technology, Massey University



# S5

## Characterizing Honey Composition by Hyperspectral Analysis

Authors: Hien T.D. TRUONG<sup>1</sup>, Richard ARCHER<sup>1</sup>, Pullanagari REDDY<sup>1</sup>, Marlon M REIS<sup>2</sup>

Mānuka honey is a honeybee product derived from *Leptospermum scoparium* nectar known as an Apitherapy. The antibacterial activity of Mānuka honey principally corresponds to methylglyoxal (MGO) compound, which is different from other native honey having hydrogen peroxide. MGO was converted from dihydroxyacetone (DHA) presented in *L. scoparium* nectar. In addition, Mānuka honey is also found the diversified phenolic profile performing high antioxidant characteristics. Some biochemical compounds are just in Mānuka honey and so play an important role as chemical markers. The authenticity of Mānuka honey is highly required to determine the quality of Mānuka honey not just only in New Zealand, but also in the world. To overcome the fraudulent issues in honey market, several conventional methods are applied (HPLC&GC-MS and the pollen DNA analysis). However, they are very sampling-destructive, laborious and time-consuming. Recently, food analysis has been applied hyperspectral imaging which is a non-destructive, fast and highly accurate technique. Hyperspectral imaging is the combination between spectroscopy and computer vision method, which can analyze the spectral discrepancy of biochemical compounds based on the absorption of electromagnetic radiation. Therefore, in this research, we apply hyperspectral imaging in combination with chemometric methods to determine the authenticity of Mānuka honey at industrial environment level as well as verify the mānukaness level at the comb from honey frame of beehives.

- Defining the “mānukaness” score to evaluate the quality of Mānuka honey
- Regional variation highly impacts on the prediction of “mānukaness”
- Industrial relevance: Honey Industry

Affiliations: <sup>1</sup>Massey University, Palmerston North, New Zealand, <sup>2</sup>AgResearch, Palmerston North, New Zealand



# S6

## Mid-infrared Quantification of Calcium for Postharvest Produce Management

Authors: Shanshan Liu<sup>1</sup>, Ringo Feng<sup>2</sup> and Peter J. Swedlund<sup>1</sup>

A non-destructive method to quantify the calcium content in fresh fruits can inform postharvest management because a low calcium correlates with a greater susceptibility to fruit degradation. This study explored the use of mid-infrared spectroscopy (MIR) to quantify  $\text{Ca}^{2+}$  based on changes to spectra of a calcium binding ligand, EDTA. Incrementally increasingly complex systems were studied, from single component synthetic solutions of EDTA to 3 component synthetic solutions with  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$  and EDTA and then to a system derived from kiwifruit ash dissolved in EDTA. Quantification was achieved by using Multivariate Curve Resolution-Alternating Least Squares (MCR-ALS) to analyse MIR spectra. Some pre-processing such as offsets and derivatives were applied for separating overlapping bands on spectra. In 2 component solutions MCR-ALS could accurately quantify Ca directly. In 3 components systems and the kiwifruit ash MCR-ALS could accurately quantify Ca from the 2<sup>nd</sup> derivative of the spectra. For example, in kiwifruit ash systems the  $r^2$  values were between 0.65 and 0.87 while the slopes were between 0.72 and 1.05 for calcium and magnesium. These results support the hypothesis that MIR could be used to estimate the concentration of  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  in fruit model systems based on the shifts in the bands of cation binding ligands and support further study into non-destructive methods for whole fruit systems.

- Core finding: Infrared and MCR-ALS can quantify calcium in fruit ash systems with EDTA.
- Core finding: There is potential for non-destructive  $\text{Ca}^{2+}$  quantification for fruit sorting
- Industrial relevance: Improved postharvest management minimises waste and enhances sustainability

Affiliations: <sup>1</sup> Food Science Programme, University of Auckland, <sup>2</sup>The New Zealand Institute for Plant and Food Research Limited



# S7

## Use of simulation to specify safe operating conditions for counter-current spray drying of heat-sensitive materials

Authors: Ramin Razmi, Wei Yu, Brent Young, Meng Wai Woo

A new one-dimensional numerical counter-current spray dryer model was developed within the MATLAB environment as a fast design tool. The model is able to capture the drying process of milk droplets with different ranges of initial droplet size distribution. Other key features of the model are the ability to capture particles' re-entrainment points numerically and the elliptic nature of the mass and heat transfer phenomena between hot air and droplets/particles under the counter-current airflow; both phenomena are non-trivial numerically. The initial part of this report addresses the numerical intricacies in the development of the predictive framework. In the latter part, the new simulation toolbox was used to explore the safe design for the counter-current spray drying of milk powder. Despite the energy efficiency of counter-current spray drying, there is no adoption of this technology by the dairy industry. This report will numerically explore some of the concerns in the production of heat-sensitive milk powder using counter-current spray drying, and suggestions for making in-roads in this area were identified.

- The numerical intricacies of adopting the one-dimensional predictive framework to counter-current spray dryers were addressed. These challenges are due to particles' possible entrainment by the counter-current airflow and the elliptic nature of the transfer phenomenon considering the counter-current movement of particles and hot air.
- The capability of capturing the particle re-entrainment phenomena for different ranges of droplet size was added to the numerical framework. This feature of the model avoids predicting an unlimited range of possible counter-current air flow rates. This is very important to know when pushing the boundary of counter-current operation. The predictive framework is then able to identify unsuitable conditions to prevent particle entrainment.
- An iterative scheme similar to the typical Eulerian-Lagrangian iterative scheme in CFD simulation was utilized. The elliptic nature of the mass and heat transfer phenomena between two phases was numerically captured using this model's feature. The iterative scheme does not require and is not bounded by estimation of the outlet conditions.
- The operational limits of counter-current spray dryers were evaluated using the simulation toolbox. It was observed that there is a tendency for the outlet air to reach the wet-bulb conditions of the air. This is not so commonly encountered in co-current dryers and has to be avoided for the counter-current configuration.
- The new simulation toolbox can be used to explore the safe operating condition for counter-current spray drying of milk to avoid any concern with regard to excessive heating of particles and high velocity of air relative to the size distribution of droplets/particles. It is important to highlight that despite the energy efficiency of counter-current spray dryers compared with co-current ones, there is no adoption of this technology by the dairy industry.

Affiliations: Department of Chemical & Materials Engineering, University of Auckland



# S8

## Melatonin and Tryptophan (Indolamines) Content in New Zealand Grown Cherries

Authors: **Iqra Zulfiqar**, Sharon Henare, David Popovich

Monoamine neurotransmitters like indolamines serotonin (5-hydroxytryptamine) and melatonin (5-methoxytryptamine) were first identified in mammals and now have been ubiquitously found in plants. The effect of melatonin and serotonin on human health and their functions in plants are well known. However, there is not much data on indolamine content in NZ grown produce. Furthermore, in the literature there is no standard method or protocol for the extraction and quantification of melatonin and its precursors (serotonin, tryptophan and tryptamine) from plant material. For this reason, an analytical method was developed using HPLC- Fluorescence. This method serves as initial starting point for analysis of indolamines in different fruits and vegetables. The long-term objective is to create a database of the indolamine contents for NZ grown export fruits and juices. NZ grown cherries will be the starting fruit to provide proof of concept and feasibility. I hypothesize that because NZ has a unique growing environment (UV index, volcanic soil, etc) that there will be elevated melatonin and other indolamines in NZ grown cherry varieties. For extraction different solvents and ultrasonication will be explored. It is important to know how stable melatonin and its precursors are during processing and storage. Cherries will be processed to make juice to examine the effect of pasteurization on indolamines content in cherry juice.

- Core finding: Melatonin and tryptophan is present in cherries
- Core finding: Levels are variable
- Industrial relevance: increase value of export

Affiliations: School of Food and Advanced Technology, Massey University



# S9

## In vitro simulation of curcumin digestion, absorption and post-prandial anti-inflammatory function.

Authors: **Giovanna Castillo-Fernandez**<sup>1,2</sup>, Fran Wolber<sup>1,2,3</sup>, Lara Matia-Merino<sup>2</sup>, Noha Nasef<sup>1</sup>, Harjinder Singh<sup>1</sup>, Matt Golding<sup>1,2</sup>

Curcumin, found in turmeric, is a bioactive of polyphenolic structure, which has demonstrated antioxidant and anti-inflammatory functionality. Curcumin's hydrophobicity means that it is often supplied with different dietary fats as a carrier system. However, fat is known to be pro-inflammatory. After dietary fat consumption, it goes through the circulatory system in what is known as post-prandial lipaemic state. Such state sustained for prolonged periods can lead to imbalance of oxidants and antioxidants, which can lead to inflammation, a risk factor for development of metabolic diseases including arteriosclerosis. We can manipulate the structure and composition of the carrier system (emulsion) to change the uptake of both digestive fatty acids and lipophilic bioactives, thereby reducing the inflammatory response. In this study, curcumin-loaded oil-in-water emulsions with different structures and fatty acid composition, are expected to modulate their ability to deliver lipophilic bioactive compounds. The deliver efficacy is associated with the composition, shape, and size of the resulting mixed micellar particles that are formed after small intestinal lipolysis. To measure bioavailability of curcumin during digestion, micellar particles are applied to polarised monolayers of intestinal epithelial cells to evaluate their absorption and the ensuing production of lipoproteins. Finally, the physiological activity of the bioactive compound, is assessed with lipoproteins applied to macrophages to assess their effect on cells' production of oxidative stress and inflammation markers following lipid uptake. The aim is to model the mammalian physiological processes of curcumin-loaded emulsion digestion, assimilation by the gut, release into the circulation, and interaction with circulating inflammatory cells.

- Core finding: This model embodies mammalian physiological relevance for lipid digestion process.
- Core finding: This system can support evidence on the modulated absorption of nutrients.
- Industrial relevance: This simulation model can be applicable to the study of various bioactive compounds.

Affiliations: <sup>1</sup>Riddet Institute, <sup>2</sup>School of Food and Advanced Technology, Massey University, <sup>3</sup>Centre for Metabolic Health Research, Massey University



# S10

## Daily lycopene accumulation and excretion after supplementation of 'Moonglow' tomato in female rats

Authors: Umani S. Walallawita,<sup>1</sup>; Frances M. Wolber,<sup>1</sup>; Ayelet Ziv-Gal,<sup>3</sup>; Marlena C. Kruger,<sup>2</sup>; Julian A. Heyes,<sup>1</sup>

'Moonglow' is an orange heirloom tomato variety with >97% of its lycopene in the more bioavailable cis- isomeric form. This study evaluated the kinetic effect of feeding of 'Moonglow' tomato. Fifteen 9-week old female Sprague Dawley rats were fed tomato powder (0.35 mg lycopene /kg BW) once daily for 5 days. Plasma, liver, faecal and urine samples were tested for total and cis/trans isomers of lycopene using ultra-high-performance liquid chromatography. Plasma and liver lycopene concentrations on day 1, 2, 3, 4 and 5 were 0.13, 0.31, 0.35, 0.42, 0.60 ( $\mu\text{mol/L}$ ) and 3.24, 7.95, 9.73, 15.54, 15.57 ( $\mu\text{mol/kg}$ ) respectively. Only tetra-cis-lycopene was detected in the plasma at each daily time point. Liver accumulated both cis- and trans- isomers, with cis-lycopene being 5X greater than all-trans-. Plasma lycopene concentration increased significantly throughout the supplementation period and reached the concentration reported to be physiologically beneficial in humans (0.42  $\mu\text{mol/L}$ ) after four days. Of the lycopene fed to rats, little was detected in the urine (0.19%); nearly half was excreted in faeces (43.1%). Lycopene accumulated in the liver over time with 52% of lycopene that was retained in the body located in the liver at day 5. The mean apparent absorption of lycopene on day 5 was 58%. These results suggest that consumption of 'Moonglow' by humans to achieve an effective plasma concentration could be achieved at a more reasonable intake of ca. 200 g fresh tomatoes per day.

- Core finding: Plasma lycopene reached 0.42 within 4 d of 'Moonglow' feeding.
- Core finding: Liver accumulated 52% of retained lycopene within 5d of 'Moonglow' feeding
- Industrial relevance: Potential for 'Moonglow' tomato cultivation as a better source of lycopene.

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# S11

## *In vitro* gastro-small intestinal starch digestion behaviour of whole wheat grains

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Wheat is one of the important staples in the world. Whole-grain consumption has been popular nowadays due to its health benefits. However, it is important to understand the starch digestion behavior of whole grains in different formats. This study evaluated the microstructure of whole wheat grains in intact, cut, kibbled, and milled forms in their raw and cooked state. The starch digestion behaviour of these grain formats was evaluated during *in vitro* gastro-small intestinal digestion, and changes in their microstructure were observed. The processing of grains from raw intact to kibbled grains and flour form increased the overall starch hydrolysis (%) during simulated digestion by 7 and 14 times, respectively. Furthermore, cooking the grains increased the expected glycaemic index of kibbled grains and flour to  $90.11 \pm 2.56$  and  $119.15 \pm 0.79$ , respectively. Micrographs from the scanning electron microscope showed that starch granules were digested from the exposed surface of the grains during sequential phases of digestion. The bran layers present in the intact raw and gelatinised grains prevented starch hydrolysis by the digestive enzymes. However, the size reduction processes resulted in disruption of bran and intact endosperm cells; and further cooking resulted in structures becoming highly susceptible to digestion. This study provides a fundamental understanding of the impact of the processing of whole grains on their starch digestion behaviour. These results can be useful in the selection of grain format to develop low glycaemic whole grain products.

- Core finding: Starch digestion behaviour of whole wheat is dependent on the grain microstructure
- Core finding: Processing can result in almost complete digestion of starch from nearly no digestion
- Industrial relevance: The format of whole wheat grains is crucial for developing low glycaemic products

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# S12

## *In vitro* cellular responses of novel rutin-casein composites

Authors: **Anubhavi Singh**, Ali Rashidinejad, Raise Ahmad

Flavonoids such as rutin are bioactive compounds that exhibit various health-promoting properties (e.g., antioxidative and anti-inflammatory activities). However, owing to their hydrophobicity and poor solubility, their bio-accessibility and bioavailability in the physiological systems is very low. Therefore, there is a need for designing delivery systems that improve the solubility of these bioactive compounds in such systems. The current study investigated the cytotoxicity of two newly invented rutin-protein composites (known as FlavoPlus 1 and FlavoPlus 2) in Caco-2 (intestinal epithelial) cell lines. Compared to control (untreated) rutin, both composites contain rutin in a more hydrophilic and biocompatible form and can be used as efficient delivery systems for the incorporation of rutin in functional food products. The findings of this study so far suggest that higher concentrations of both composites are less cytotoxic than control rutin (at 500µg/ml), indicating that the novel processing has improved rutin bioavailability in the cell model system. Furthermore, both products showed higher antioxidant activity (at 500µg/ml) and increased phenolic content (at 200µg/ml), which suggests the enhancement of free radical scavenging property when compared with control rutin. Taken together, the preliminary results of the current study indicate that rutin-casein composites are potential sources of bioavailable rutin, which may be used for improving digestibility and oral delivery of this compound via functional food products and/or supplements. Further experiments are being conducted to assess the functional and digestion characteristics of these novel composites in an *in vitro* gastrointestinal digestion model, after their incorporation into functional food models.

- Core finding: Higher antioxidant potential was observed in the case of novel rutin composites.
- Core finding: Reduced cytotoxicity occurred at higher concentrations of rutin-protein composites.
- Industrial relevance: The novel composites can be incorporated into various functional food products.

Affiliations: Massey University, Riddet Institute, AgResearch



# S13

## Hybrid *Paneer* (cottage cheese): Influence of mung bean protein isolate on the texture, microstructure, and gastro-small intestinal digestion *in vitro* of *paneer*

Authors: Shince Tojan, Lovedeep Kaur and Jaspreet Singh

Partially replacing milk proteins with plant protein isolates is an interesting opportunity to develop novel and sustainable dairy products. The effects of partially (30%) replacing milk with mung bean protein isolate (MBPI) on microstructural, functional characteristics and *in vitro* protein digestibility of paneer (acid-heat coagulated cheese) was investigated. Confocal microscopy results showed protein aggregates of varying sizes within the casein matrix in cow milk-mung bean protein based hybrid paneer (HP) in contrast to a much uniform structure in cow milk only paneer (CMP). Small amplitude oscillatory tests showed higher  $G'$  values than  $G''$  values throughout the frequency range and showed higher  $G'$  values for HP compared to CMP, indicating greater elastic nature of the former. Texture profile analysis of HP showed a significant reduction ( $p < 0.05$ ) in hardness, cohesiveness, chewiness, and springiness values from CMP. *In vitro* gastro-small intestinal digestion of paneer was also performed to evaluate its protein digestibility. The analysis of the digests showed that the free amino N values for HP were significantly lower ( $p < 0.05$ ) than CMP during small-intestinal phase. This was further confirmed from SDS-PAGE results. Further investigation is necessary to develop plant protein-incorporated paneer with improved textural and digestion characteristics.

- Core finding: Incorporation of MBPI led to significant reduction in textural attributes of paneer.
- Core finding: The hybrid paneer also showed lower *in vitro* protein digestibility.
- Industrial relevance: Opportunity to develop plant protein incorporated dairy based cheese analogues

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# S14

## Effect of ultrasound on structural and physicochemical properties of sweet potato and wheat flours

Authors: Rongbin CUI<sup>1</sup>, Fan ZHU<sup>1</sup>

Ultrasound technologies are increasingly used for modification of the physicochemical properties of food systems. In this study, effects of ultrasound (20 kHz, 750 W) up to 20 h on physicochemical properties of two varieties of sweet potato flour were studied and compared with those of commercial wheat flour. Ultrasound induced structural changes on starch evidenced mainly in the morphological characteristics of starch granules and in their degrees of crystallinity. Longer treatment significantly decreased enthalpy change of gelatinization, pasting viscosities, gelling properties, while increasing *in vitro* starch digestibility of raw flour. Besides, prolonged treatment also reduced total phenolic content and *in vitro* antioxidant activities of sweet potato flour, mainly due to pyrolysis and release of hydroxyl radical caused by cavitation. The extent of these changes was seen to depend on treatment time and indicated degradation and modifications of the chemical compositions (e.g., starch and polyphenol) of flours. This study suggests the ultrasound as a non-thermal and energy-saving technique has potential to modify flour functionalities.

- Core finding: Ultrasound processing modified properties of sweet potato and wheat flours
- Core finding: Phenolic compounds were degraded in prolonged ultrasound treatments
- Industrial relevance: Novel functionalities of ultrasound-treated flour in starch-based food development

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# S15

## Protein differences in the simulated gastrointestinal digestion of milk from different species

Authors: **Catherine Maidment**, Assoc/Prof Aiqian Ye, Dr Siqi Li, Dr Jessica Gathercole, Dr Anita Grosvenor

Milk is a highly nutritious food source that has been an important component of the human diet since approximately 8000 BC. Adults use milk from other species as an additional food source as it provides a valuable source of proteins, fats, vitamins and energy. Although cow's milk is the most frequently consumed, milk from other species such as goat, sheep and even deer are becoming more prevalent in the market either for specialised products or as a less allergenic alternative. Prior to consumption, milk is processed either to kill microbes, preserve its shelf life or to prepare it for further production. During digestion, milk proteins are hydrolysed into absorbable peptides and amino acids. Various factors such as species, breed, lactation stage and processing treatments have been shown to influence milk composition and structure, affecting how milk proteins are digested and consequently how the nutrients are absorbed. This project investigates how processing treatments such as pasteurisation and homogenisation affect the protein structure and digestion of milks from ruminant species such as cow, sheep, goat and deer. The knowledge generated will provide a better basis for developing easily digestible milk products. To investigate this, milk obtained from several species and processing variants will be characterised using LC-MS/MS proteomic analysis following *in vitro* semi-dynamic digestion. It is expected that differences will be discovered regarding peptide sequences, cleavage location and post-translational modifications.

Affiliations: Massey University, AgResearch



# S16

## Pepsin induced milk coagulation mechanism and curd properties

Authors: **Mengxiao Yang**, Aiqian Ye, Harjinder Singh, David Everett, Zhi Yang, Elliot Paul Gilbert

In milk and dairy product digestion, coagulation of casein micelles occurs and plays a key role in the gastric transit of proteins. This coagulation is induced by specific hydrolysis of the Phe<sup>105</sup>-Met<sup>106</sup> bond of  $\kappa$ -casein which is catalysed by pepsin when pH > 5, and which results in destruction of the protective effect by  $\kappa$ -casein on the casein micelle surfaces. The mechanism and kinetics of  $\kappa$ -casein hydrolysis induced by pepsin and the relationship between hydrolysis and casein coagulation have not been previously reported. In this study, the effect of pH (6.7 - 5.3) and pepsin concentration (0.11 - 2.75 U/mL) on  $\kappa$ -casein hydrolysis and the coagulation properties of casein micelles in cow skim milk were investigated at 37 °C using reverse-phase HPLC, oscillatory rheology, and confocal laser scanning microscopy (CLSM). It was shown that the hydrolysis of  $\kappa$ -casein followed a combined kinetic model of first-order hydrolysis and pepsin denaturation. Increasing the pepsin concentration increased the hydrolysis rate and reduced the coagulation time. The hydrolysis rate was also pH dependent and reached a maximum at ~pH 6.0. As the decrease in pH reduces the electrostatic repulsions between para-casein micelles, the extent of  $\kappa$ -casein hydrolysis required for coagulation decreased markedly from 71% to 35% when pH decreased from 6.3 to 5.3. In addition, the evolution of storage modulus ( $G'$ ) and the firming rate ( $dG'/dt$ ) of the coagulum with hydrolysis time were strongly affected by the pH and pepsin concentration, which generally matched well with the coagulum microstructures observed by the CLSM.

- Core finding: The hydrolysis of  $\kappa$ -casein induced by pepsin at pH above 5 followed a combined kinetic model of first-order hydrolysis and pepsin denaturation.
- Core finding: The extent of  $\kappa$ -casein hydrolysis required for pepsin induced coagulation decreased markedly from 71% to 35% when pH decreased from 6.3 to 5.3.
- Industrial relevance: The findings of this project can provide instructions for the dairy industry to produce better digestible milk

Affiliations: Massey University, Riddet Institute



# S17

## Evaluation of oat volatile flavour compounds during commercial processing

Authors: **Helena Odinet**<sup>1</sup>, Xingchen Li, Indrawati OEY<sup>1, 2</sup>, Biniam KEBEDE<sup>1</sup>

Oats are one of the most commonly consumed cereals due to their nutritional benefits and functional health properties. As oats contain higher lipid content in comparison to other cereals, they are more prone to lipid oxidation, leading to off-flavours and aromas. Therefore, during processing, heat treatment is used to inactivate lipid degradation enzymes and promote the development of flavours through Maillard Reaction and its side reactions (e.g., Strecker degradation). This research aims to investigate the evolution of the volatile flavour compounds during commercial oat processing. GC-MS fingerprinting and chemometrics approaches enabled detection of an increased number of volatile compounds from different chemical classes (aldehydes, ketones, furans, etc.) during processing. The high temperature processing steps, specifically kilning and steaming, seem to have a crucial impact in the formation of thermal-associated volatile flavour compounds (e.g., Strecker aldehydes and furans). In conclusion, the present study demonstrated the potential of integrated fingerprinting and chemometrics methods to investigate the volatile changes during commercial oat processing. This research provides crucial information to the food industry to optimise the processing steps used to produce rolled oats.

- Core finding: Fingerprinting and chemometrics approach enabled detection of high number of volatiles
- Core finding: Kilning and steaming steps lead to formation of furans and Strecker aldehydes
- Industrial relevance: This research provides a crucial information to the food industry to optimise their processing aiming a specific flavour profile

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# S18

## The influence of drying technique on physicochemical properties and functionalities of hemp protein isolate

Authors: Xuan DONG<sup>1</sup>, Yaoyao PENG<sup>1</sup>, Meng Wai WOO<sup>2</sup>, Siew-Young QUEK<sup>1,3\*</sup>

Hempseed contains approximately 30% of protein with a complete amino acid profile, 30% of oil with numerous amounts of polyunsaturated fatty acids, especially the omega-3 and omega-6, 25% carbohydrate with a substantial amount of dietary fibres, and a considerable amount of vitamins and minerals. Hemp protein isolate (HPI) is considered a superior protein source than some other plant-based proteins being its higher level of arginine and lower content of antinutritional compounds. Previous studies have reported the physicochemical properties and functionalities of HPI. However, the impact of different drying techniques on HPI has not been well studied. In this study, we investigated the effect of spray drying and freeze drying on the physicochemical properties and functionalities of HPI obtained from the hempseed meal by alkaline extraction. The powder properties such as colour, density, moisture content, and water activity of both the spray and freeze-dried HPI powders were measured. Thermal properties, including denaturation temperature and denaturation enthalpy of both HPI powders, were examined using differential scanning calorimetry. The impact of drying method on the protein subunit composition was studied by gel electrophoresis. Protein functionalities, including solubility at different pH, water and oil holding capacities were also investigated. The results from this study have provided some scientific insight for HPI powder production and application in the food industry in light of the use of plant-based protein for environmental sustainability.

- Drying method applied did not alter the thermal properties of the HPI
- Powder properties and functionalities were affected by drying technique applied
- Provide scientific insight for HPI powder production and application

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# S19

## Heat-induced interactions and structural changes of proteins in sheep skim milk

Authors: Zheng Pan<sup>1</sup>, Aiqian Ye<sup>1\*</sup>, Anant Dave<sup>1</sup>, Karl Fraser<sup>1,2</sup>, and Harjinder Singh<sup>1</sup>

Sheep milk contains higher levels of total solids and major nutrients than cow milk. Casein micelles in sheep milk differ in average diameter, hydration, and mineralization from those of cow milk. However, sheep milk has lower heat stability than cow milk. UHT sheep milk leads to high sedimentation during storage due to the formation of protein aggregates. In the present study, sheep skim milk (SSM) was heated in the range 75-90°C for 0.5-30 min and the protein interactions were characterized by determination of casein micelle size, protein composition and microstructure. Casein micelle size increased significantly depending on both heating temperatures and holding time, with a maximum ~292.6 nm of the size compared to ~174.6 nm for unheated SSM. RP-HPLC showed that the level of denatured whey proteins associated with casein micelles increased with both heating temperature and time, reaching ~95% at 85-90°C for 10 min treatments. The casein micelle size increased more rapidly when the level of denatured whey proteins associated with casein micelles was greater than ~95%. Dissociation of  $\kappa$ -,  $\beta$ -, and  $\alpha_{s1}$ -casein from casein micelles were observed in all heated samples. The aggregation among casein micelles was also observed by TEM. The changes in casein micelle size induced by heat treatment of SSM may be attributed to mainly aggregation of casein micelles and partly association of denatured whey proteins with micelles. These results provide a better understanding of the lower heat stability of sheep milk.

- Casein micelle size increased by 70% when heating at 85 and 90°C for 30 min.
- Whey proteins associated with casein micelles influences micelle size changes.
- Considerable aggregation among casein micelles was observed at 85-90°C for 30 min.
- Dissociation of  $\beta$ -CN from micelles is the critical factor causing aggregation.
- Offer novel insights about why sheep milk has a lower heat stability

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# S20

## De-structured starch as a “clean-label” ingredient and its potential in food applications

Authors: **Cai Ling Ang**<sup>a,b</sup>, Lara Matia-Merino<sup>a</sup>, Kaiyang Lim<sup>c</sup>, Kelvin Kim Tha Goh<sup>a,b</sup>

Starch is an important ingredient in many food products, either as an additive to enhance the physico-chemical properties or as a key ingredient in many staple foods. With the increased pursuit of natural products, there is an increasing demand for “clean-label” starches. This study focuses on: (i) the development of physically-modified waxy potato starch (de-structured starch), (ii) the characterisation of the molecular and physico-chemical properties, and (iii) the exploration of its potential food application. The starch samples were modified at elevated temperatures of 120, 130, 140, and 150 °C for 30 min at a stirring speed of 300 rpm, in a pressurized reactor. Treatment at 120 °C successfully reduced starch granules into their amylopectin chains. Further temperature increment (130 – 150 °C) resulted in the fragmentation of amylopectin chains, which led to a reduction in the particle size and viscosity of the samples. Furthermore, de-structured starch treated at 120 °C exhibited shear-induced gel characteristics, which remained stable during storage. Such shear-induced properties can potentially be exploited in food applications where improved structure upon shearing is desired, e.g. in enhancing the stability of whipping cream. In addition, a synergistic interaction (gel hardness) was noted in whey protein isolate gels made with 140 °C de-structured starch. Such behaviour was absent in the control sample (gel prepared with whey protein isolate and gelatinised waxy potato starch). Hence, from the physico-chemical properties of these de-structured starches, we envisage potential applications of such materials as functional “clean-label” ingredients to aid in the structuring of foods.

- Core finding: De-structured starch was obtained at  $\geq 120$  °C for 30 min (stirring rate of 300 rpm)
- Core finding: Shear-induced gelation was observed with 120 °C de-structured starch
- Core finding: Synergistic interaction was noted between whey protein and 140°C de-structured starch
- Industrial relevance: De-structured starch can potentially be used in structuring foods for improved functionality

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# S21

## Understanding the Quality Characteristics of *Sous vide*- cooked Goat Meat from New Zealand Breeds

Authors: **Mariero H. Gawat**<sup>1,2</sup>, Lovedeep Kaur<sup>1,2</sup> and Mike Boland<sup>2</sup>

New Zealand has an untapped goat meat industry that has to be developed as a significant source of healthier red meat. Feral (wild goat), Boer (meat breed) and its crosses are significant goat meat sources for the country's domestic and export market. The market value of goat meat depends on the type of breed, with meat from feral goats usually priced lower than that from Boer. However, the differences in quality of meat from these breeds are yet unknown. This study investigated meat quality characteristics, including nutritional composition and microstructure, from 1–2-year-old goats from these goat breeds. Data showed that Boer goat meat has a significantly higher carcass yield than feral- 16.18 kg and 13.74 kg, respectively. Meat quality characteristics were determined by subjecting longissimus dorsi (LD) and semimembranosus (SM) to sous vide cooking at 60 °C for 6 h. Between muscles, irrespective of breeds and sex, SM was more tender than LD after cooking, and tenderness of SM from feral was comparable to SM of male Boer crossbreed. However, shear force values of sous vide cooked meat from all breeds showed toughness that translated to moderately acceptable to unacceptable (50-60N). Among the meat quality parameters evaluated, tenderness was highly influenced by breed ( $p < 0.001$ ), sex ( $p < 0.001$ ) and muscle type ( $p < 0.001$ ). Meat from feral should not be discriminated against meat from Boer. Although, suitable age and sex of feral should be considered to obtain meat that can compete against the meat bred Boer. This study is a work in progress.

- Core finding: Meat from feral is not necessarily inferior to meat from the popular Boer goat.
- Industrial relevance: The findings would be beneficial for the NZ goat meat industry.

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# S22

## Alternative Method to Produce High-Value Product from Low-Quality Cocoa Beans

Authors: Noor Ariefandie Febrianto<sup>1,2</sup>, Fan Zhu<sup>1</sup>

Indonesian cocoa has been recognized as low quality cocoa beans, which is contributed by high amount of unfermented cocoa beans. Unfermented cocoa beans are characterized by low flavour quality and excessive bitterness/astringency. During cocoa beans processing, the beans was mainly utilized to obtain cocoa butter, whereas the resulted cocoa cake was treated as by-product. In the subsequent process, the cocoa cake may be used as an additive to produce cocoa powder or be used to produce low quality cocoa product. Cocoa cake from unfermented cocoa beans is rich in bioactive compounds such as psychopharmacologically active methylxanthines and beneficial polyphenols. In this research, an alternative method was developed focusing on the utilization of cocoa cake by-product. The method include the hydraulic pressing or solvent extraction of cocoa butter from unroasted cocoa beans, solvent extraction to extract the bioactive compounds from cocoa cake, and modified roasting of cocoa cake to obtain low bitterness/astringency cocoa powder with good flavour properties. With the development of this alternative methods, it is possible to obtain high value products from unfermented cocoa beans, elevating the value of cocoa cake by-product.

- There is a method to process low quality cocoa into high valued products;
- Alternative methods could produce versatile product for food industries;
- Industries may adopt the methods to further enhance the valorisation of cocoa beans.

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# S23

## Investigation of the effect of shearing and pH on extraction of soluble protein from *Spirulina* (*Arthrospira platensis*)

Authors: **Neda Irvani**<sup>a</sup>, Indrawati Oey\*<sup>a</sup>, Alan Carne<sup>b</sup>, Dominic Agyei<sup>a</sup>, Biniam Kebede<sup>a</sup>, Joy Sim<sup>a</sup>

Securing adequate protein supply in the future needs new initiatives to address the environmental impact of current meat-derived protein production systems. Microalgae have potentials as an alternative protein source, as microalgae can be produced at industrial scale and the protein has a nutritionally adequate amino acid profile. *Arthrospira platensis* (spirulina) is a high protein-containing (up to 70% dry weight) micro-algae, and the protein isolated can be used in developing the functional properties of food products. However, there are several challenges associated with the development of cost-effective, low energy consuming technologies and extraction of protein under food-grade conditions from micro-algae such as spirulina. This study investigated the effect of high-speed shearing force as a function of pH on the extraction of protein from spirulina. Spirulina was subjected to ultra-turrax shearing at various pH, ranging from pH 2.0 to 12.0. It was found that alkaline pre-treatment in combination with homogenisation with Ultra-Turrax efficiently facilitates the degradation of algal cell wall. Increasing shearing speed from 3000 to 23000 rpm resulted to significant rise on soluble protein recovery. However, a significant difference was not observed when shearing time increased from 1 to 3 min. Hence, maximum extraction of soluble protein (405.34 mg g<sup>-1</sup> DW) was obtained at pH 12.0 with homogenization of 23000 rpm for 3 min, and a minimum extraction of protein occurred at pH 3.0 (14.51 mg g<sup>-1</sup>). Alkaline pH, combined with ultra-turrax shearing, provides an economical method for extraction of protein from spirulina, that is industrially scalable.

- Core finding: The optimal conditions for shear-rupturing *Spirulina* were determined.
- Core finding: The optimal pH for extraction of protein from *Spirulina* was determined.
- Industrial relevance: The conditions reported for protein extraction from spirulina are industrially scalable.

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# S24

## Linking Coffee Quality with Terroir

Authors: Joy Sim<sup>a</sup>, Russell Frew<sup>a,b</sup>, Indrawati Oey<sup>a</sup>, Biniam Kebede<sup>a</sup>

The popularity of coffee around the world continues to grow rapidly, especially in Asia and China. Accompanying the rise in coffee consumption is the increasing number of fraud cases such as mislabelling and adulteration of coffee as pure Arabica species. To protect coffee producers and consumers, efficient analytical methods are needed to evaluate the authenticity and quality of coffee. Traditional geochemical, stable isotope and trace element methods have been used for the determination of coffee origin. Even though these are well established and accurate methods, they tend to be expensive and complex tools that involve a lot of time, destructive sample preparation steps and chemicals. Vibrational spectroscopy has been suggested as a cheap, sustainable, non-destructive and rapid tool to perform routine analysis on coffee. The aim of this research is to develop a rapid method to verify the origin of coffee using vibrational spectroscopy, and to link origin terroir with coffee aroma and health qualities through chemometrics and data fusion. This would facilitate the select breeding of special coffee bean cultivars with unique sensorial and health-promoting properties and protect the market from adulteration. Furthermore, the outcome of this work will support producers of high-quality coffee to obtain legal protection through designated geographical indicators.

- Core finding: Vibrational spectroscopy combined with chemometrics to classify coffee based on origin
- Core finding: Chemometrics model to predict geochemical attributes using NIR. No study integrating traditional geochemical and vibrational spectroscopic methods
- Core finding: Modern chemometrics linking coffee flavour data with terroir for rapid prediction
- Industrial relevance:
  - Rapid and efficient selection of quality green beans;
  - Rapid methods for verifying authenticity and detecting adulteration;
  - Designated geographical indicators for producers for promotion and profit;
  - Developed methods are transferable to a wide range of high value foods (dairy, honey, tea, spices, etc.)

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# S25

## Understanding the impact of hop glycosides and biotransformation and their potential to enhance beer flavour

Authors: **Rebecca Roberts**<sup>1</sup>, Graham Eyres<sup>2</sup>, Pat Silcock<sup>2</sup>, Phil Bremer<sup>2</sup>, Franco Biasioli<sup>2</sup>

To meet consumer demand for hop-flavour driven beers, there is an increasing interest to control, optimize and predict hop flavour in beer. Only some aroma compounds present in hops appear to directly contribute to beer flavour due to changes in volatile compounds during fermentation. The current knowledge of the effect of yeast on hop volatile compounds during brewing and fermentation is limited. This makes it impossible to accurately predict how hop additions will impact hop flavour in finished beer. Therefore, the overall aim of the research is to gain a mechanistic understanding of the transformation reactions responsible for hop flavour development in beer. The release of aroma compounds from non-volatile glycosides has been well established in wine literature. This study is interested in hop glycosides and their contribution to the hop flavour of beer. To tease apart the objectives of this research, model beer systems will be used with the addition of purified hop glycosides, pure aroma compounds and stable isotopes to identify transformation reactions of individual compounds during fermentation. This will enable further understanding that the role of yeast has on modulating hop flavour in beer through biotransformation reactions.

- Investigate hop aroma transformation pathways during brewing and fermentation.
- Results will enable predictions of hop flavour in finished beer and facilitate new beer flavour and style development

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# S26

## Flavour volatiles of raw and cooked lamb treated with wine lees

Authors: **Sung Yi-Ting**, Biniam Kebede, Allan Richardson, Alaa Bekhit

This project aimed to determine the effect of wine lees drenching treatment on the volatiles of raw and cooked lamb samples. A total of 30 lambs were subjected to one of the following drenching treatments: zero wine lees drenching (control group) (CG), weekly 10 mL of lees drench group (10W), weekly 20 mL of lees drench (20W), daily 10 mL of lees drench (10D), and daily 20 mL of lees drench (20D). Lamb loins were obtained at 24 hrs post-mortem, vacuum packed and stored at -20°C for 6 months. A GC-MS fingerprinting method was implemented to investigate the volatile compounds of raw and cooked lamb samples. The GC-MS fingerprinting enabled a detection of more than 50 volatile compounds in the raw and cooked. Next, advanced chemometrics methods were applied to compare the volatile profile of different treated samples and selected discriminant compounds. The detected volatiles can be grouped into acids, aldehyde, furans, ketones, sulphur, and terpenes chemical classes. Alcohols were the largest group of the volatiles (36%) in the raw samples, whereas alcohols and aldehydes (both 32%) were the dominating volatiles in the cooked lamb group compared to the raw samples. In the raw samples, a higher concentration of alcohols was detected in the 20 D samples compared to the raw control samples. However, the drenching treatment seems to have a limited effect on the cooked samples. Overall, there was limited effect of wine lees drenching on the volatiles of the raw and cooked samples under the described experimental conditions.

- Core finding: Alcohol and aldehyde were detected in higher amounts in cooked than to raw samples.
- Core finding: The drenching treatment has a limited effect on the volatile of cooked lamb samples.
- Industrial relevance: Provides information about the effect of feed (in this case lees drenching) on the volatile flavour compounds on the final products

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# S27

## Glycosidically bound volatiles in Tamarillo: a key hidden flavour source for fruit processing and product development

Authors: Xiao CHEN, Siew Young QUEK, Bruno FEDRIZZI, Paul KILMARTIN

Many volatile compounds in plants accumulate as flavourless and non-volatile glycoconjugates, named glycosidically bound volatiles (GBVs). They are mainly *O*-glycosides or *O*-diglycosides attached with an aglycone that can be monoterpenes, benzenoids, esters or alcohols. GBVs have long been recognized as potential reservoirs for fruit aroma as they are not endpoint irreversible products and can liberate aromatic aglycones during fruit ripening or industrial processing. This research focuses on the characterization of GBVs in tamarillo fruit with considerations on the effects of hydrolysis strategies and incubation time. GBVs in tamarillo fruit are isolated using solid-phase extraction and different hydrolysis strategies, including enzymatic and acidic hydrolysis, are subsequently applied to yield aglycone isolates. The potential aroma contribution of GBVs is further elucidated by the molecular sensory approach. Gas chromatography-olfactometry in combination with aroma extract dilution analysis is used as a state-of-the-art flavour-chemistry methodology to identify key odorants in aglycone isolates. This study addresses the role of GBVs as an important source of fruit aroma that could modify the original sensory characteristics of tamarillo juice.

- Enzymatic hydrolysis shows advantages on the release of bound aglycones
- A hydrolysis time of 48h promotes the liberation of bound terpenes and benzenoids
- Aromatic aglycones can improve sensory properties of tamarillo products

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# S28

## Hop Terroir in New Zealand; expansion of the New Zealand hop industry.

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The popularity of craft beer has increased over recent years due to an increasing diversity in flavour derived from a combination of ingredients and how they are added during the brewing process. Hops are a key ingredient in creating distinct flavours in craft beer. New Zealand's hop industry produces hops with unique characteristics, exporting 85% of the harvest to international markets. Despite this, New Zealand hops represent only 1% of the global market share. Currently, New Zealand's commercial hop production is focused only in the Tasman region and there is a need to expand the potential growing locations to increase output to allow for increased exports. Analysis of the influence of New Zealand terroir has been conducted on grapes and wine, however knowledge of the effect of terroir on hops is lacking. The present study focuses on how volatile compounds of New Zealand hop cultivars change due to terroir comparing two growing hop regions, Tasman and Central Otago. Analysis of volatile profiles was conducted using gas chromatography mass spectrometry (GC-MS) and chemometrics. Differences in volatile compounds for six hop cultivars from the two locations were analysed over two harvest years to understand the influence of terroir on the profile of New Zealand hops. While hop genetics (cultivar) was the dominant factor in determining the volatile profile, there were differences between locations that may subtly change the flavour quality of the individual hop cultivars and indicate that like grapes, a terroir effect may exist.

- Core finding: Hop genetics (cultivar) was the dominant factor compared to growing location.
- Core finding: Subtle terroir effects on were determined between hop locations.
- Industrial relevance: Provides evidence to facilitate expansion of the New Zealand hop growing industry.

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# S29

## Meaningful measurements of mushiness: Understanding the food texture for Dysphagic.

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As a consequence of the constant rise in life expectancy globally, a vast emerging market of 400 million of elderly over 80 years is predicted by 2050. It has been projected that dysphagia affects 30-40% of the elderly population. For this reason, providing special food and nutrition required for them is demanding urgent attention. The texture becomes the key aspect to consider when designing dysphagia-oriented meals to ensure the safety of swallowing. Currently, the consistency of meals is routinely assessed by perceiving their thickness level through the surface of a spoon (IDDSI spoon tilt test). The particle size is evaluated through a slot between fork prongs (IDDSI fork test). Both of these tests involve highly subjective based evaluations. This highlights the need for a reliable quantification method to verify the texture modified meals represent the prescribed consistency levels. To this end, the present study was conducted to investigate the reliability of the extrusion technique as an objective method to measure the meal consistency and particle size of commercially prepared IDDSI (International Dysphagia Diet Standardization Initiative) level four and five meals. Study results revealed that the extrusion method is a promising method for predicting particle size and differentiating IDDSI level 4 and 5 categories. Therefore, the author would like to propose this technique as a feasible and standardized methodology for evaluating the product's texture and particle size for industrial purposes.

- Core finding: The extrusion test provides objective measurements of particle size.
- Core finding: The extrusion test is capable of differentiating IDDSI level 4 and 5 meals.
- Industrial relevance: Extrusion test provides reliable guidelines of the product texture for manufacturers

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# S30

## Effect of packaging texture and font colour on the product perception: A qualitative study.

Authors: **Annu Mehta** and Damir Torrico

Innovative products are launched in the market every year to meet the expectations of modern consumers. Several foods on the shelves are similar in taste, nutrition and price. Consumers select products based on visual properties before tasting. We aimed to investigate the effect of extrinsic characteristics (packaging texture and labels) on the perception of quality. Two approaches (sensory assessment and focus group) were adopted to evaluate different juice packaging (glass bottle, plastic bottle, tetra pack and pouches) and labels with different font colours (white, red, green, and orange) on quality and sensory perception. Consumers perceived glass bottle to be of high quality and prefer to buy the juice in glass bottles. Qualitative analysis discerned that consumers perceived glass bottles to be recyclable, reusable and environmentally friendly. Consumers were also comfortable with the plastic and glass bottles as compared to the tetra pack and pouch because they can see and evaluate the quality of the product before buying. The participants (N=15) considered the juice from the red font label to be more premium than other labels. Differences were found in the perception of sourness and freshness of juices from labels of different font colours. Based on principal component analysis, the emotion terms “adventurous”, “energetic”, “enthusiastic” were related to the red label and the emotion terms “quiet”, and “mild” were related to white labels. This study illustrates the importance of using qualitative methods to gain insights into the interactions between different sensory modalities in consumer quality judgements.

- Core finding: Qualitative studies can provide deeper insights into the consumers' perception of products.
- Core finding: Colour plays an important role in communicating product's sensory information to consumers.
- Industrial relevance: Purchase decisions and acceptance are based on multisensory information perceived from the product's characteristics

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# S31

## Shellfish consumption and recreational gathering practices in Northland, New Zealand.

Authors: Sarah Guy<sup>1,2,\*</sup>, Sally Gaw<sup>1</sup>, Sarah Beaven<sup>1</sup>, Andrew Pearson<sup>2</sup>

Bivalve shellfish are filter feeders making them a significant potential cause of human exposure to contaminants. In New Zealand, shellfish are a popular food that are harvested commercially and recreationally. In the 2008/09 adult nutrition survey the general population reported consuming 7 g of shellfish per day on average, however, consumption rates varied across the population. The limited quantification of shellfish consumption poses challenges for exposure assessment, particularly in regional populations with higher than average consumption.

A survey of shellfish consumption and shellfish gathering practices was undertaken in Northland in summer 2019/20. Seventy six percent (n = 229) of total survey respondents (n = 302) reported consuming shellfish, with an average daily consumption of 4.8 g of shellfish per day. Cooked shellfish was preferred to raw shellfish with only 16% of shellfish consumed raw. Almost three quarters of respondents (72%, n = 166) reported eating recreationally gathered shellfish, with half (n = 114) of all shellfish consumers physically gathering shellfish. While the key motivation for gathering was pleasure, providing food was also of great importance. When selecting gathering places, respondents prioritised proximity and shellfish quantity over shellfish quality. Respondents reported collecting shellfish from a limited number of geographically close gathering sites. In general, the quality of shellfish was perceived to be high, and unchanged, although some respondents reported a decline in the quantity due to over-gathering. Ethnicity was the main parameter influencing shellfish consumption whereas age and gender influenced shellfish gathering.

- Core finding: Shellfish consumption is common in Northland and much is recreationally gathered
- Core finding: The average daily consumption of shellfish amongst consumers is 4.8 g/day
- Industrial relevance: Results of consumption frequency and amount will support risk assessments

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# S32

## The effect of animal protein on hybrid analogue structural properties

Authors: Kizzy Rennie

Many plant-based meat analogues have been manufactured from soy protein due to availability and functionality. Although considered very similar in nutrient profile, other sources such as wheat gluten and pea protein are necessary to improve overall structure. Sensory attributes, however, require further additives and ingredients which may not guarantee customer acceptability. Therefore, hybrid meat analogues have been created to bridge the consumer gap. This research explores the effect of incorporating meat and dairy protein on meat analogue's structural, nutritional and sensory properties. Dairy protein isolates and rendered meat products repurpose manufacture waste and act as meat extenders in transition diets. Additionally, they reduce the dependency on traditional hydrocolloids. With final data pending, preliminary results show that the addition of meat and dairy provide expected improvements such as amino acid composition, fiber formation and colour. However, factors such as moisture loss, lack of structural integrity increase with higher ratios due to weak interactions within the gel network. Therefore, the manipulation of processing factors such as temperature, pressure and shear force are equally effective to produce a more stable final product which this research also explores and compares.

Affiliations: Massey University



# S33

## Rheological characteristics of some plant proteins and their ability to form meat analogues

Authors: **Boning Mao**<sup>1,2</sup>; Lovedeep Kaur<sup>1,2</sup>, Suzanne Hodgkinson<sup>2</sup>, Mustafa Farouk<sup>3</sup> and Jaspreet Singh<sup>1,2</sup>

Plant-based meat analogues are booming in the market due to the increasing consumer demand for healthy and sustainable protein foods. This research aims to develop hybrid meat products containing both plant and animal (muscle) proteins by applying a novel thermo-mechanical process. It is hypothesised that the combinations of plant and animal proteins would be molten and restructured to form uniform hybrid meat like textures during thermomechanical processing. Our experiments have indicated that the structured meat analogues can be obtained through this unique process using plant proteins alone such as pea and soy proteins. A layered and fibrous microstructure was observed for meat analogues produced by 100% pea or soy protein concentrates; however, the formulation containing 100% rice protein concentrates did not form any aggregates. According to the rheological characterisation of the plant protein pastes (27.5 wt%), soy protein could form stronger gel, while rice protein formed weaker structure after heating and cooling during temperature sweeps. In the next phase of the project, the production of hybrid meats using combinations of different plant and muscle proteins will also be done. The structure and functionality of selected protein combinations will be characterised, and the conformational changes of proteins and protein interactions during processing will be determined to understand the mechanism of how they form a fibrous structure during processing. The protein profile as well as the amino acid digestibility of hybrid meats products will also be analysed.

- Core findings:
  - Layered and fibrous microstructure was observed for meat analogues produced by 100% pea/soy protein concentrates; however, the formulation containing 100% rice protein concentrates did not form any aggregates during processing.
  - Soy protein could form stronger gel, while rice protein formed weaker structure after heating and cooling in the temperature sweeps.
- Industrial relevance:
  - This research leads to develop novel high-protein meat-like fibrous foods with improved sensorial and nutritional attributes.
  - This project presents an opportunity for the meat industry to add value to low-value meat ingredients.

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# S34

## Nutritionally-rich plant protein-dairy protein meat analogues produced by thermomechanical processing

Authors: Akashdeep Singh BENIWAL<sup>1</sup>, Jaspreet SINGH<sup>1</sup>, Alan HARDACRE<sup>1</sup> and Harjinder SINGH<sup>2</sup>

Structured or texturised plant proteins are used as meat substitute or meat extenders due to their sensorial similarities to meat, but they have inferior nutritional quality. Inclusion of dairy proteins as a functional ingredient during structuring process could improve the functional, structural, and nutritional characteristics of meat analogues. The objective of this research was to 1) understand the mechanism of fibre formation during thermomechanical processing of plant and dairy proteins; 2) determine the best formulations and processing condition for fibre formation; 3) evaluate their consumer acceptability. Experiments have been conducted utilising various plant and dairy protein combinations to create high protein anisotropic structure using thermomechanical processing. The physicochemical characteristics, texture and microstructure of created plant-dairy based meat analogues were analysed and compared with different types of meats (beef, pork and chicken). Three selected formulations of plant-dairy based meat analogues and one commercial sample were evaluated by 91-member sensory panel for flavour, texture, and overall liking, using a 9-point hedonic scale. Our results showed that process parameters play an important role for fibre formation in structured meat analogues and displayed a linear relationship with textural responses. Therefore, a wide variation in structured meat analogues textures (i.e. chicken-like, beef or pork) could be achieved by controlling the protein ratios and process conditions. The consumer acceptability of plant-dairy based meat analogues was similar or better than the commercial samples for overall liking, flavours, textures, and off flavours. These nutritionally rich meat analogues developed from different dairy and plant proteins have the potential to capture a significant proportion of “flexitarian” market.

- Protein functional properties plays an important role final structural and textural properties
- Process parameters play an important role for fibre formation in structured meat analogues
- Industrial relevance: To create nutritionally rich meat analogue by incorporating both dairy and plant protein ingredients

*\*Some experimental details are suppressed due to confidentiality attached to this research project*

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# S35

## Effect of pulsed electric fields on hoki gonad lipid extraction and characteristics

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Recent studies have outlined the benefits of marine derived phospholipids, especially for brain health. As a result, there has been increased interest in lipid extraction techniques that achieve an optimal yield of phospholipids from marine biological material. Hoki male gonad is a substantially under-utilised by-product component of the fish processing industry and is reported to contain substantial amounts of phospholipids. Pulsed electric fields (PEF) treatment is a pre-treatment method that involves the application of short electric pulses that can be applied to biological tissue and results in electroporation and a subsequent increase in the permeability of the cell membrane. PEF has been found to be effective for the extraction of bioactive compounds from plant and animal cells. However, the efficacy of PEF has yet to be examined for enhancing lipid extraction from marine sourced materials. Therefore, the present study aimed to investigate the use of PEF as a pre-treatment for the extraction of phospholipids from hoki male gonads, and to examine whether PEF has any effect on the characteristics of extracted lipid. Hoki male gonads were subjected to PEF treatment at varying voltages (2.5, 5 and 7.5 kV) and frequencies (25Hz, 50Hz, and 100Hz) at a fixed pulse width of 20  $\mu$ s. Following PEF pre-treatment, lipid extraction was carried out using a method involving ethanol and hexane. The phospholipid content and fatty acid composition were analysed using 31P NMR and GC-FID, respectively. The optimum extraction conditions and the effect of PEF treatment intensity on the lipid characteristics will be reported.

- Core finding: The effect of PEF on lipid profile will be reported
- Core finding: The positional distribution of EPA and DHA of hoki gonad will be reported
- Industrial relevance: This research will provide valuable lipidomic information of hoki gonad and support future utilization of this under-utilised by-product.

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# S36

## Lipidomic profiling of three lean fish species head and skin

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The present study investigated the lipidomic profile (fatty acid profile, positional distribution of n-3 fatty acids and phospholipid content) of head and skin of three lean fishes (gurnard, ribaldo and snapper). Gurnard head (GH) and snapper head (SnH) were found to contain a higher amount of total lipid (5.9- 6.3%) than other samples (1.2-3.9%) including a considerable amount of bioactive n-3 fatty acids such as EPA (GH=9.05%; SnH=5.06%), DPA (GH=2.78% ; SnH=2.93%) and DHA (GH=12.8% ; SnH=7.72%) in the polar lipid fraction. DHA was found to predominate in the *sn*-2 position for gurnard head and snapper head. On a wet tissue basis, head (gurnard=3440 nmol/g, ribaldo=2620 nmol/g and snapper=3950 nmol/g) was found to be a better source of phospholipids than skin (gurnard=3180 nmol/g, ribaldo=1670 nmol/g and snapper=1160 nmol/g). Therefore, of the samples analysed, gurnard head and snapper head were found to be the best source of bioactive n-3 phospholipids.

- Gurnard, ribaldo and snapper fish head and skin were analysed for lipids.
- § Lipid content varied significantly across the fish part and species.
- § All samples contain considerable amounts of EPA, DPA and DHA contents.
- § Phospholipid was found to be highest in head compared to skin.
- § Gurnard and snapper samples had high DPA and DHA in *sn*-2 position.

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# S37

## Characterisation of Anthocyanin-Bound Pectin-Rich Fraction Extracted from New Zealand's Blackcurrant (*Ribes nigrum*) Juice

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This study was conducted due to the limited knowledge on polyphenols that are bound to pectin in blackcurrant (BC) juice. A dialysed ethanol precipitated fraction isolated from BC juice was found to contain carbohydrate (78% w/w), uronic acid (21% w/w), protein (4.8% w/w), anthocyanin (3.9% w/w) and calcium (2.2% w/w). The pectin-rich fraction had a  $pK_a$  value of 1.67, a zeta-potential of -23.1mV (pH 4.8) and a degree of esterification of  $65.2 \pm 10.2\%$ . Constituent sugar analysis showed mostly galacturonic acid, rhamnose, arabinose and galactose, and NMR spectroscopic analysis showed that it was rich in rhamnogalacturonans with arabinogalactan sidechains. This fraction was highly pigmented with cyanidin 3-*O*-rutinoside being the major anthocyanin. Liquid chromatography showed anthocyanins retained in the fraction that failed to be extracted by methanol, suggesting the presence of bound anthocyanins. Multi-angle laser light scattering data showed the presence of two fractions of  $\sim 258$ kDa present at 9.4% w/w and  $\sim 76.4$ kDa at 55.2%. The latter also showed higher UV signal (280nm) signifying that proteins and/or polyphenols were present mainly in the second fraction. This study suggests that the pectin found in the BC juice is a complex material with bound protein and anthocyanin, and therefore, will likely cause interactions with protein when mixed in high-protein beverage systems.

- Core finding: BC juice pectin contains bound proteins and anthocyanins that are not removable by solvent extraction and dialysis.
- Core finding: The pectin comprises of two fractions ( $\sim 258$  and  $\sim 76$ kDa) with dominance of proteins and/or anthocyanins in the smaller fraction.
- Industrial relevance: Anthocyanin-protein-pectin complexes in BC juice may destabilise high-protein beverage systems.

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# S38

## Synthesis of structured phospholipid containing nervonic acid from *Malania oleifera* by lipase-catalysed acidolysis

Authors: **Geoff Ang**<sup>1,2</sup>, Hong Chen<sup>3</sup>, Siew Young Quek<sup>1,2</sup>

Oil from *Malania oleifera* contains a high level of nervonic acid from 40.92% to 55% and it is one of the few species of plant that contains nervonic acid. Nervonic acid is vital in the development and maintenance of brain health. Research have reported that the reduced nervonic acid levels in blood or brain tissues is related to the increased risk of mental disorders. Hence, nervonic acid supplementation can potentially be used to treat and prevent the risk of these mental disorders. Lipase-catalysed transesterification modifies the fatty acid chain on the glycerol backbone by incorporating nervonic acid into a phospholipid's structure. The bioavailability of nervonic acid can potentially be increased due to the higher bioavailability of phospholipid than triacylglycerol or free fatty acid form. Oil was initially extracted from the seed of *M. oleifera* and the nervonic acid from the oil is purified to 97%. Secondly, lipase-catalysed transesterification was conducted to modify the phospholipid structure by incorporating nervonic acid into phospholipid. The transesterification reaction conditions to produce structured phospholipid were optimised and the structured phospholipid were then purified for use for further studies.

- Core finding: Nervonic acid was successfully purified to a high extent.
- Core finding: Structure phospholipid contains nervonic acid was produced.
- Industrial relevance: Potential of tailored fats/oils to suit food industrial application.

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# S39

## Selenium speciation and *in vitro* bioactivities of selenium-containing proteins from radish and cardamine leaves

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Accumulated evidence has shown that selenium (Se) from yeast and plants exerts health benefits, yet few studies have emphasised on proteins. Recently, Se-containing proteins (SCPs) from plants have been demonstrated to support positive health implication. This study, therefore, aimed to profile Se species and investigate the *in vitro* bioactivities of SCPs extracted from the leaves of *Brassica* plants, i.e. radish (*Raphanus sativus*) and cardamine (*Cardamine violifolia*). Advanced methodologies were used to characterise selenocompounds in which organic and inorganic Se species were identified in the leaf extracts and their SCPs in different proportions. SCPs also exhibited *in vitro* antioxidant potential and cell cytotoxicity, which were improved due to the incorporation of Se into proteins. These findings highlight the possibility of SCPs as promising therapeutic agents as well as introduce a feasible solution to minimise agricultural waste.

- Core finding: Organic and inorganic Se species were identified in the leaves and their SCPs.
- Core finding: SCPs possessed *in vitro* bioactivities relevant to human health sustenance.
- Industrial relevance: Plant biomass could be developed into higher-value products.

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# S40

## Encapsulation of rutin in Pickering emulsion stabilized with OSA modified nanoscale quinoa, maize, and potato starch particles

Authors: Mejo Kuzhithariel Remanan, Fan Zhu

Rutin is a polyphenol compound with excellent therapeutic potentials such as anti-oxidant, anti-inflammatory, anti-diabetic, body weight control, and good safety profile. However, its incorporation in food and pharmaceuticals is difficult due to low water solubility, poor absorption and bioavailability under physiological conditions. This study focuses on the encapsulation of rutin to overcome these limitations and to increase bioavailability. In the food industry, emulsions are suitable for the encapsulation of hydrophobic nutraceuticals because they can easily be manufactured using clean-labelled ingredients. Standard emulsifying devices would allow easy adaptations in existing production lines. Emulsions are thermodynamically unstable, and emulsifiers are used to increase stability. In this study, starch nanoparticles (SNPs) prepared by nonsolvent nano-precipitation after octenyl succinic acid (OSA) modification was examined as a candidate for stabilizing emulsions. Modified quinoa, maize and potato SNPs (0.25 wt %) were used as stabilizers. Rutin was dissolved in oleic acid and used as the internal phase of oil-in-water emulsions. The rutin encapsulated Pickering emulsions were prepared, and studied emulsion and storage stability. All the emulsions prepared were stable with 100 % encapsulation efficiency on day 1, which results in emulsions with a rutin concentration of 750 µg/g. The Pickering emulsions with OSA modified quinoa SNPs showed rutin encapsulation efficiency of 98.4 % and was higher than OSA modified maize (95.5 %) and potato (96.2 %) SNPs after storage for 31 days. The results showed that rutin could be successfully encapsulated in emulsion stabilized with food-grade modified SNPs.

- Core finding: OSA modified SNPs can be used as stabilizers to form stable Pickering emulsions with increased bioavailability of rutin.
- Core finding: OSA modified quinoa SNPs showed more encapsulation efficiency after a storage of 31 days.
- Industrial relevance: These results were useful for designing and fabricating emulsions which can be utilized in rutin delivery.

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# S41

## *Bacillus cereus* biofilms: a reservoir of food safety issues

Authors: **Yiying Huang**; Jon Palmer; Steve Flint

*Bacillus cereus* (*B. cereus*) is a well-known foodborne pathogen capable of causing two types of gastrointestinal diseases, diarrhoea and emesis. It is of particular concern for the food industry causing food safety issues, due to its ability to produce spores, form strong biofilms and produce emetic and enterotoxins. In this study, six *B. cereus* strains from either potato or dairy samples were grown on stainless steel surfaces, a common material used in food manufacturing. We found that biofilms are a greater reservoir of spores than planktonic cultures, in addition, biofilm spores were significantly more heat resistant than planktonic spores grown in lab media and milk. Furthermore, it was found that more Hbl (haemolytic) toxin was detected in biofilm grown conditions compared to liquid planktonic culture by using both immunoassay and RT-qPCR assay. These results suggest that biofilms of *B. cereus* in a food processing environment maybe a greater risk factor to food safety than initially thought.

- Core finding: Biofilm contains more heat resistance spores.
- Core finding: Biofilm produce more toxins.
- Industrial relevance: More attention on controlling biofilm is needed in food industry.



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# S42

## Profiles of *Vibrio parahaemolyticus* biofilm and its roles in sanitizer tolerance

Authors: Dana Wang

*Vibrio parahaemolyticus* is a pathogenic bacterium associated with seafood. The food safety issues associated with this pathogen involve consumption of ready-to-eat, undercooked seafood. The current food safety risk associated with seafood in New Zealand is low however, based in experience internationally, this is expected to change with global warming. Surveys in New Zealand have shown *V. parahaemolyticus* to be present in shellfish in the warmer summer months. While the risk of food contamination is generally low, the role of biofilm formation in processing plant in providing an additional source of contamination is unknown. This study examined the biofilm formation of 10 isolates of *V. parahaemolyticus* isolated from both seafood and clinic. The effect of biofilm formation on survival when exposed to cold shock and sanitizer treatment will be examined using flow cytometry. This will help us determine the risk of seafood contamination during processing.

- This study highlights flow cytometry to detect various cell population inside biofilm matrix, to assess cold shock and sanitizer stress effect on culturable, viable-but-nonculturable (VBNC) and dead cells inside.
- It reveals sanitizer tolerance phenotypes of *V. parahaemolyticus* in simulated seafood processing environment.
- It emphasizes the risk of seafood contamination during processing, laying foundation for sorting out biocontrol strategies to ensure seafood safety.

Affiliations: Massey University



# S43

## Surface-independent strategy of *in situ* AgNP formation with high antibacterial and antiviral activities toward bioprotective applications

Authors: **Boyang Xu**<sup>1</sup>, Kang Huang<sup>1</sup>, Tilo Söhnle<sup>1</sup>, Siew Young Quek<sup>12</sup>

The outbreak of COVID-19 has reemphasized the importance of antibacterial and antiviral coatings. Silver nanoparticles (AgNPs), albeit as good antibacterial agents, holds intrinsic toxicities against a broad spectrum of pathogenic microorganisms. Efforts towards fixation of AgNPs are confined by the necessity of surface anchors crosslinked with specialized treatments. Here, we report a versatile approach that can form AgNPs coatings *in situ* on diverse surfaces. Silvernization is firstly achieved by oxidative polymerization of phenolics in neutral buffer, then the AgNPs are grown on the deposited phenolic matrices by reduction of diluted silver nitrate. Successful coating formation was achieved on surfaces including plastics, glass and metal. This has been confirmed by visual inspection of the coating after silver nitrate treatment as well as EDS. The as-formed AgNPs has typical diameter ranging from 5-20nm with narrow size distribution. The coatings exert strong antibacterial and antiviral activities. More than 4 log CFU/mL reduction of both *Escherichia coli* and *Bacillus cereus* was achieved within 2 hours contact. Apart from contact inactivation assay, the AgNP films were incubated with the above bacterial suspension at 10<sup>7</sup> CFU/mL, and up to 7 log reduction was achieved within 2 hours incubation. The T7 bacteriophage was used as a model naked virus, and the AgNPs coatings resulted in 8 log PFU/mL reduction within 2 hours of contact. The current strategy endows omnipresent surfaces with antibacterial and antiviral functionalities, which provide new insights into the development of green and effective bioprotective coatings.

- The AgNPs coatings can be *in-situ* formed on various surfaces.
- The AgNPs coatings exert outstanding antibacterial and antiviral activities.
- The versatility of the current strategy allows fast and efficient modification of various surfaces that are omnipresent in the food industry, with antimicrobial and antiviral functionalities.

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# S44

## Biomedical collagen from fish skin – Adding value to fisheries waste

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Industrial processing of fish recovers only 20 - 50% of the original raw material as edible portions. Wastes generated during this process are rich sources of bioactive compounds which can be utilised to produce high-value products. Type-I collagen from fish skin has commercial potential for biomedical materials due to its excellent biocompatibility, biodegradability and low antigenicity. During processing the native triple-helical conformation of the type I collagen must be preserved. For this reason, conditions should be maintained during collagen extraction to avoid denaturation. The process is yet to be optimised and is the subject of this study. Here, type-I collagen is extracted from tarakihi fish skin by modifying the treatment steps and agents of a commercial bovine tendon collagen extraction method. Swelling of fish skin during pre-treatment was found to be the most important factor determining the effectiveness of the entire collagen extraction process. Sodium hydroxide was found to be most effective pre-treatment agent, which was supported by the UV absorption spectra, showing no remaining non-collagenous proteins. The extraction and fibrillogenesis steps were modified by changing the weight: volume ratio of skin: hydrochloric acid used for extraction, the concentration of sodium hydroxide used for fibrillogenesis and the pH at fibrillogenesis. Fourier Transform Infrared Spectroscopy (FTIR) results confirmed the extracted collagen was native type-I collagen. Scanning Electron Microscopic (SEM) images showed that the pore structure was suitable for biomedical applications. This study demonstrates the potential for upscaling this modified method to produce a high value product from fish processing wastes.

- Core finding: Swelling of fish skin is the important determinant of the collagen extraction process
- Core finding: Biomedical collagen from fish skin can be extracted by the modified method
- Industrial relevance: Modified method can be developed to industrial-scale to extract biomedical collagen

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# S45

## *In Vitro* Antioxidant Properties of New Zealand Hass Avocado By-product (Peel and Seed) Fractions

Authors: **Danxia Shi**, Prabhu Balan, Marie Wong, David Popovich

Avocado (*Persea americana*) is a popular tropical fruit, which is rich in fibre; vitamins C, B and E, unsaturated fatty acids (oleic, linoleic, stearic, palmitic, capric, linolenic, and myristic acids); potassium; and other nutrients. In avocado oil production, there is a large amount of bio-waste, which could be a potential source of bioactive molecules.

The utilization of avocado seed, and peel could promote avocado industry growth. Furthermore, there research is scarce on avocado by-product produced in New Zealand (NZ). This study explores the antioxidant properties of NZ Hass avocado by-product. The total antioxidant capacity was evaluated by DPPH and ABTS assays, the total polyphenol content of avocado by-product extracts was measured by Folin–Ciocalteu assay. The procyanidin B2 content was investigated by HPLC. In Soxhlet extraction study, TPC of ripe seed extract (64.55 mg GAEs/g) was higher than other extracts. Seed extracts showed higher antioxidant activity than peel extracts. In flash chromatography separation study, low polarity fraction (FLP) of ripe peel had the highest DPPH, and ABTS scavenging capacity ( $90 \pm 0.08\%$ ;  $93 \pm 0.05\%$ ). This research provides valuable evidence to support NZ-avocado by-product as a source of antioxidants in the future.

- Core finding: NZ-avocado by-products can be a source of antioxidants
- Core finding: seed has higher antioxidant activity
- Industrial relevance: biowaste may have value

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# S46

## Characterization of Dominant Acetic Acid Bacteria and Yeasts Associated with Kombucha Sold in New Zealand

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Kombucha is a sparkling infused tea beverage fermented with a symbiotic culture of acetic acid bacteria (AAB) and yeast commonly known as SCOBY. The market demand for Kombucha continues increasing due to its perceived health benefits and naturalness. This study aims to determine the characteristics of dominant AAB and yeast associated with Kombucha beverages that are commercially available in New Zealand market. AAB and yeasts were isolated from six beverages using glucose yeast extract peptone mannitol (GYPM) and yeast extract glucose chloramphenicol (YGC) agar, respectively. The recovered isolates were subjected to morphological characterization using microscopic observation. AAB were examined with ethanol oxidation, glycerol ketogenesis, lactate oxidation and acid production from different carbohydrates. The AAB isolates were identified by sequencing the V3-V4 hypervariable regions of 16S rRNA genes, whereas the yeast isolates were identified using the API 32C kit in combination with sequence analysis of the rRNA gene internal transcribed spacer (ITS) regions. The mean pH of the Kombucha samples ranged from 3.21±0.01-3.90±0.01, and the mean total soluble solids ranged from 1.87±0.06-7.00±0.00 °Brix. Mean AAB counts ranged from 4.97±0.06-5.63±0.02 log CFU/ml, while yeast counts ranged from 4.75±SD - 5.69±0.01 log CFU/ml. The dominant AAB species identified were *Gluconobacter oxydans* and *Acetobacter musti* and the yeasts were *Dekkera bruxellensis*, *Schizosaccharomyces pombe*s, *Hanseniaspora valbyensis*, *Brettanomyces anamalus*, *Pichia kudriavzevii* and *Saccharomyces cerevisiae*. Knowledge of the fermenting SCOBY in Kombucha will aid producers to have better management of their fermentation process to assist in the production of more consistent high quality Kombucha beverages.

- Core finding: The AAB and yeasts were only found in domestic produced Kombucha samples rather than imported samples.
- Core finding: Two AAB species and six yeast species were isolated and identified from three Kombucha brands sold in New Zealand.
- The presence of *A. musti* in Kombucha has not been reported before.
- Industrial relevance: Generally, Kombucha producers find it difficult to produce consistent high-quality products with high carbonation, low calorie, and low alcohol to meet the national regulation. Therefore, knowledge of the fermenting microorganisms will assist the producers to have better management of the fermentation process to produce consistent high-quality products across the industry. Also, the data obtained in this study will create opportunities to develop novel products with specific properties to meet diverse markets and consumer

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# S47

## Characterisation of lactic acid bacteria isolated from New Zealand organic naturally fermented sauerkraut: an initiative towards developing an autochthonous probiotic starter culture

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Natural fermentation of sauerkraut relies on the presence of autochthonous cabbage lactic acid bacteria (LAB), resulting in products of variable quality and safety, making the process unreliable for large-scale commercial production. With the increasing demand for natural, clean label products, there is a need to develop well-defined, organic plant-based starter cultures with predictable characteristics for better control of the sauerkraut fermentation process to ensure product consistency, safety, and quality. This study aims to characterise *in-situ* LAB isolated during the natural fermentation of New Zealand (NZ) organic sauerkraut and to utilise this knowledge to develop an indigenous starter culture. LAB in white and red sauerkraut produced by natural fermentation (1.5% NaCl w/w; 18-20 °C) of NZ grown organic cabbage were isolated on MRS agar from brine samples collected over the eight-week fermentation period. Titratability acidity, pH, total LAB count and total aerobic mesophilic count of the brine samples were also determined. LAB dominated the fermentation process, resulting in a rapid increase in acidity which is desirable to suppress the growth of spoilage and pathogenic microorganisms. A total of 175 presumptive LAB isolates were obtained based on colony morphology, Gram staining and catalase testing. Further characterisation is underway to select for LAB isolates with probiotic potential.

- Core finding: Rapid acidification occurred during fermentation of organic white and red sauerkraut.
- Core finding: High LAB counts in the final product are important for potential probiotic activity.
- Industrial relevance: There is increasing consumer interest towards organic, plant-based probiotic fermented foods. The abundance of LAB in naturally fermented organic sauerkraut may serve as a useful source of wild-type strains that are well-adapted to the food matrix and may exert additional functionalities and health-promoting properties, which are not available in commercial starters. Thus, capturing such strains with beneficial attributes is an important initiative to develop novel plant-based starter cultures for the organic fermented vegetable industry both in NZ and beyond.

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# S48

## Formation and characterisation of water-soluble whey protein aggregates as an emulsifier

Authors: **Salil Wagh** and Sung Je Lee

A recent trend among consumers is a propensity to consume a higher amount of protein due to health issues and ailments which have developed due to modern lifestyle. Among many different types of food proteins from plant or animal sources, whey proteins are considered as the most effective and suitable protein for human consumption as far as gastro-intestinal assimilability is concerned. The goal of the present research was to investigate the synthesis and characterisation of soluble whey protein aggregates and use the aggregates as an emulsifier in oil-in-water emulsions aiming at developing the delivery systems of bioactive compounds. Soluble whey protein aggregates were formed via partial denaturation by heat treatment (68-85°C for 0.5-60 mins) of solutions of whey protein isolate (WPI) (2-8% w/w) at different pH levels (6.0-6.8). This resulted in a mean particle diameter (D4,3) ranging from 20 to 150 nm and a zeta potential of < -25 mV, depending on the conditions of thermal treatment, pH and protein concentration used. The concentration of soluble whey protein aggregates was measured using spectrophotometer. The soluble aggregates produced were investigated for their ability as an emulsifier as well as a stabiliser in an oil-in-water emulsion with an oil fraction (MCT) of 15%. The stability of emulsions against changes in pH and ionic strength was analysed with a help of particle size, zeta potential and visual observation. The results of this study provide insight into the application of soluble whey protein aggregates as a potential delivery system for bioactive compounds.

- Core finding: A soluble dispersion of whey protein aggregates by controlling heat treatment and pH.
- Core finding: Application of soluble whey protein aggregates as an emulsifier in oil-in-water emulsions.
- Industrial relevance: Different food structures (e.g. gels and creams) using whey protein aggregates.

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# S49

## Development of stirred yoghurt enriched with avocado pulp

Authors: **Mingyang Guo**<sup>a</sup>, Sung Je Lee<sup>a</sup> and Seung Young Park<sup>b</sup>

In recent years, avocado has drawn wide attention due to their health benefits, therefore, there is potential to expand its use for food applications. As yoghurt is perceived by consumers as a healthy food, the combination of avocado and yoghurt, namely avocado stirred yoghurt, has broad market prospects. However, some features of avocado have restrained the development of avocado stirred yoghurt, such as bitterness after heat treatment and sensitivity to browning and oxidation. It's thus necessary to regulate these undesirable sensory attributes during preparation and storage of avocado stirred yoghurt. In this research, several different treatments were approached independently or in combination to treat avocado pulp, including ascorbic acid (1% and 2%), citric acid (1% and 2%), and high-pressure processing (HPP) (600MPa, 5 min). The avocado pulp was then ground as avocado puree and then incorporated into stirred yoghurt. The suitable methods were filtered by analysing the colour stability of yoghurt during storage at 4°C for 28 days. Then, the chosen methods were further analysed in terms of their effect on the other properties of yoghurt, including colour, texture, sensory and microbiological properties. The results showed that 2% w/w of ascorbic acid in avocado was most effective in maintaining the colour of yoghurt and restraining the development of rancid flavour. However, HPP treatment of avocado was less effective in controlling its browning but helped with keeping the texture of yoghurt. No side effects of these methods were found on the flavour or probiotic quality of yoghurt containing avocado.

- Core finding: 2% ascorbic acid effective in controlling the browning and rancidity of avocado yoghurt.
- Core finding: HPP treatment of avocado less effective against browning but useful in yoghurt texture.
- Industrial relevance: Use of ascorbic acid and HPP in avocado yoghurt making with desirable properties.

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# S50

## Development of a novel avocado-fortified cream cheese

Authors: Yinxuan Hu<sup>a</sup>, Sung Je Lee<sup>a</sup> and Seung Young Park<sup>b</sup>

Cream cheese fortified with the addition of avocado puree to improve its nutritional value has not been developed in the food industry. This research study aimed to develop a novel cream cheese fortified with avocado puree by determining an appropriate concentration level and a proper processing condition to prevent avocado puree from its natural degradation. Four different amounts of avocado puree (0, 10, 20 and 30% w/w) were incorporated into cream cheese to determine their effects on the quality and stability of cream cheese during storage at 4°C for 28 days. Also, three different treatments, such as addition of ascorbic acid, use of high-pressure processing (HPP), and a combination of HPP treatment and ascorbic acid addition, were used for preserving avocado puree against enzymatic browning and oxidative degradation to investigate their influence on the stability and sensory properties of avocado cream cheese. The results revealed that adding 20% (w/w) of avocado puree into cream cheese which was treated with both HPP and ascorbic acid was the most suitable approach to develop an avocado-fortified cream cheese with desired sensory properties based on consumer sensory evaluation. In conclusion, as for the avocado puree processing conditions, adding ascorbic acid into HPP-treated avocado puree could minimise its adverse effects on the cream cheese sample after mixing and extend the sample's shelf life. The results of this research provide vital insight into developing a novel avocado-fortified cream cheese with desired sensory characteristics.

- Core finding: Addition 20% avocado puree into cream cheese is most acceptable for sensory quality.
- Core finding: Avocado treated with HPP and ascorbic acid most suitable in avocado cream cheese.
- Industrial relevance: Application of avocado puree in developing novel functional food products.

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# S51

## Mamaku polysaccharide functionality

Authors: **Akshay Bisht**<sup>a</sup>, Kelvin Goh<sup>a</sup>, John Monro<sup>b</sup>, Suman Mishra<sup>b</sup>, Lara Matia-Merino<sup>a</sup>

The New Zealand black tree fern (*Cyathea medullaris*), commonly known as Mamaku in Māori, contains a water-soluble polysaccharide. The Mamaku polysaccharide (MP) was reported to exhibit complex rheological behaviours including Newtonian, shear-thickening, and shear-thinning depending on the applied shear. In this study, the effect of frond maturity on the functionality of MP was investigated. The yield and viscosity of MP was found to decrease with increased frond maturity. Moreover, the shear-thickening behaviour of the polysaccharide was lost as the fronds approached the withered stage. This suggests that there were changes to the MP at the molecular level as the fronds mature. The effect of drying method (freeze-drying: FD and oven-drying: OD) on Mamaku pith powder functionality was also studied. Hydrated FD powder exhibited a similar complex rheological properties to that of native MP. However, the shear-thickening behaviour was lost in hydrated OD powder. The reason for the loss in shear-thickening was attributed to the trapped MP within the fibrous structure of the pith during the drying process which hindered the leaching of the MP during rehydration.

- Core finding: Mamaku polysaccharide degrades with frond maturation.
- Core finding: Drying method affects the functionality of mamaku pith powder.
- Industrial relevance: FD fully grown Mamaku fronds shows potential as a food functional ingredient

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# P1

## Predicting fat in salmon fillets using snapshot HSI cameras and stitching algorithm

Authors: Yash Dixit <sup>a, b</sup>, Marlon M. Reis <sup>a, b</sup>

Hyperspectral imaging (HSI) has been an extensively researched technology regarding food quality (Gowen et al., 2007). Recently, technological advancements have led to the development of snapshot hyperspectral cameras which are ultra-compact, rapid, portable and easily adaptable to processing lines. However, snapshot cameras have limited spectral ranges which can limit its application. A solution is image stitching and recently, Dixit et al. (2020) developed an algorithm to serve this purpose. In this study, HSI data was collected for 90 samples (salmon fillets and sections) using two snapshot cameras: Vis (470-630 nm, 16 bands) and Vis-NIR (670-950 nm, 25 bands) for the assessment of fat content in salmon fillets. Fat is one of the most important quality parameters for salmon, defining it as “poor” or “rich” in flavour (Zhang et al., 2020). The collected HSI data from two cameras was stitched to produce single image covering all spectral and spatial information from both cameras per sample. Partial Least Squares Regression (PLSR) model was used to predict total fat in salmon. The validation set was used to test the prediction efficacy of the model, yielded high  $R^2_p = 0.92$  and low  $SEP = 2.33$ . Overall results showed that snapshot HSI system along with stitching algorithm can be effectively used to predict fat in salmon. The various advantages offered by the system makes it a potential candidate for real-time industrial application. In the future, the spectral range cover could allow assessment of attributes such as colour and morphological features of fillets.

- PLSR model to predict total fat in Salmon with high accuracy.
- Stitching algorithm for snapshot hyperspectral cameras.
- Ultra-compact snapshot hyperspectral camera for real-time industrial application.

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# P2

## Evaluation of low cost pocket-sized NIR spectrophotometer for estimation of fatty acids in cheeses

Authors: Mariza G. Reis, Michael Agnew, Noby Jacobs and **Marlon M. Reis**

The feasibility of low-cost pocket-sized near infrared (NIR) spectrophotometer to predict fatty acid (FA) content in commercial cheeses was investigated. Concentration and type of fatty acids in cheese influence several aspects of cheese, including microstructure, textural properties, flavour and creamy mouth feel. Two portable spectrometers, a handheld (350-2500 nm) and a low-cost, pocket sized NIR (900-1700), were utilized in this study. To increase variability between samples and to allow better calibration of NIR instruments, a broad range of cheese types were selected including cheeses with a different protein to fat ratio, manufacturing procedure, different species (cow, goat, ewe and buffalo), different ripening times and different countries of origin. The FA concentration ranged from 47.6 to 472.4 mg/g of cheese. For the majority of FA the low-cost pocket sized NIR showed similar performance as the handheld. The best estimation, using Partial Least Squares/repeated-double cross validation was observed for total saturated FA ( $R^2_{RDCV} = 0.80$ ), short FA (4:0 -  $R^2_{RDCV} = 0.75$ ; C6:0 -  $R^2_{RDCV} = 0.81$ ) and long chain FA (C14:0 -  $R^2_{RDCV} = 0.77$ ; C16:0 -  $R^2_{RDCV} = 0.71$ ; and C18:0 -  $R^2_{RDCV} = 0.72$ ), and monounsaturated FA (C18:1c9  $R^2_{RDCV} = 0.69$ ). Variable importance in the projection scores showed that the models captured different spectral information between saturated and monosaturated fatty acids. This technique allows on-the-spot analysis and could be a valuable tool for small cheese companies where new technology cost is a major obstacle for adoption.

- Discrimination of FA content of a broad range of cheese types.
- On-the-spot analysis of cheese FA characteristics
- The low cost of pocket-sized NIR spectrophotometer enables broad adoption

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# P3

## Simple and rapid method using Coconut Cream Agar to screen citrinin producers of *Monascus* spp.

Authors: Farawahida Abdul Halim<sup>a</sup>, Steve Flint<sup>a</sup>, Jon Palmer<sup>a</sup>, Musaalbakri Abdul Manan<sup>b</sup>

Red fermented rice (RFR) is fermented rice using *Monascus* spp. as a fungal starter. RFR has health benefits including a cure for diarrhoea, improved blood circulation, and other pharmacological effects. However, RFR also can produce the mycotoxin, citrinin (CIT) and that has adverse effects on the human body. Currently, there is no rapid and simple method to screen *Monascus* spp. that can produce CIT. The objective of the study was to develop a rapid and simple screening method for the detection of *Monascus* spp. that can produce CIT by using Coconut Cream Agar (CCA). RFR was spread plate on CCA and other media and incubated at 30°C for 7 days. All the media were observed under ultraviolet (UV) light every day and any *Monascus* spp. colony that produced light blue fluorescence or halo was recorded as a presumptive CIT-producer. Three different strains were isolated from CCA: (1) Strain A: Red colony, faster growth and CIT-producer *Monascus* spp. (100%) after incubation for 4 days, (2) Strain B: Red colony, slower growth and CIT-producer *Monascus* spp. (70%) after incubation for 7 days, and (3) Strain C: White colony, slower/non-citrinin-producer (0%) produce no halo after incubation for 7 days. CCA can be used as a simple and rapid method to detect CIT-producers of *Monascus* spp. The ability of *Monascus* spp. to produce CIT varied: some strains can produce CIT faster than others and some strains may not produce CIT. *Monascus* spp. strains with lower/no CIT would be ideal for RFR, providing the health benefits without the food safety concerns with CIT.

- Core finding: CCA was used to screen *Monascus* spp. strains that can produce CIT
- Core finding: Some *Monascus* spp. strains produced CIT faster (4 days) than others
- Industrial relevance: Selecting non-CIT producer of *Monascus* spp. strains as a starter culture for RFR.

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# P4

## Accelerated shelf-life testing of Sanford fish oil with antioxidant supplementation using the OXITEST

Authors: Kirill Lagutin(1) and Sabrina Tian(2)

Fish oils contain high levels of beneficial omega-3 polyunsaturated fatty acids (PUFAs). PUFAs are prone to oxidation which leads to unpleasant smell and rancid taste, that limits the shelf-life of fish oil products. One of the most effective and commonly used oxidation prevention strategies in industry is the addition of antioxidants, compounds that inhibit the oxidation process. There are many antioxidants available to manufacturers today, both synthetic and natural, including botanical extracts (rosemary, green tea, etc), lecithins, ascorbates and vitamin-based antioxidants. Antioxidant selection is an important step in the product development process. Accelerated studies is an essential tool to support the development process as it provides quick insight into oxidative stability of products.

There are several solutions for accelerated shelf-life studies including active oxygen method, oxidation stability index (Rancimat) and OXITEST. OXITEST is approved by the American Oil Chemists' Society (AOCS Cd 12c-16) as a method applicable to “all foods, oils, and fats covering a wide range of test sample types with at least 2-4% fat... directly on the whole sample, without preliminary fat separation.”

We present the application of the OXITEST to assist with natural antioxidant type and concentration selection, and performance comparison with synthetic antioxidant.

- Both BHT and tocopherols significantly increase fish oil stability.
- Natural antioxidants can provide superior stability over synthetic antioxidants.
- OXITEST is a versatile solution to assist product development

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# P5

## Effect of hydrothermal processing on the headspace volatile compounds of legumes

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Legumes are an inexpensive source of plant protein, fibre and minerals. However, an obstacle barring their full utilization is the presence of volatile compounds contributing to undesirable odours. Consequently, the study of volatile compounds in legumes is pertinent to their utilization, and it is time to revisit volatile compounds in legumes using state-of-the-art instruments. In this study, the headspace volatile compounds of three types of legumes including cowpea (*Vigna unguiculata*), chickpea (*Cicer arretium*), and kidney bean (*Phaseolus vulgaris*) were systematically investigated. Samples were procured from local market in Dunedin, then soaked and boiled in distilled water. Boiling was conducted in a covered pot to approximate home cooking. Sampling occurred during the soaking step and as a function of boiling time (up to 2 h). Legume's headspace volatiles were sampled and analysed using solid-phase microextraction and gas chromatography mass spectrometry, respectively. As processing proceeds, overall number and abundance of volatile compounds detected in the headspace decreased. Compounds associated with thermal processing, such as sulphur-containing compounds, were detected in increasing concentration for all three types of legumes. This study gives an insight into the volatile characteristic of legumes in a step-wise approach, which can inform future investigations utilizing different methods or novel technologies to manipulate the volatile profile of legumes.

- Headspace volatile compounds decreased as processing time increased.
- Prolonged processing increased thermal degradation related volatiles.
- Appropriate processing parameters can manipulate the volatile profile of legumes.

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# P6

## Combined thermal and drying processes affect protease activities of ruminants' milk

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Proteases present in milk are heat-sensitive, and they are active or inactive depending on the intensity of the heat-treatment applied. Retaining endogenous milk protease activity could improve protein digestion in the gut lumen, particularly in early postnatal life. The effect of thermal and drying processes on protease activities are well-known for bovine milk, but little is known for non-bovine ruminants' milk. This study aimed to quantify the activity of the major milk proteases (plasmin, cathepsin D and elastase) in raw bovine, ovine and caprine milk, and to examine how protease activity was affected by heating (63°C/30min or 75°C/15s) and/or drying (spray- or freeze-drying). Commercial fluorometric assay kits were used to measure protease activities. Plasmin activity in ovine milk decreased ( $p < 0.05$ ) 18% at 63°C/30min and 75% at 75°C/15s, while it decreased 69% at 75°C/15s in caprine milk. However, the drying processes did not affect ( $p > 0.05$ ) the plasmin activity in the studied ruminants' milk. In contrast, cathepsin D was only affected by the drying processes ( $p < 0.001$ ). For instance, spray-drying increased cathepsin-D activity three-fold in bovine milk. Elastase activity was affected by both thermal ( $p < 0.001$ ) and drying ( $p < 0.001$ ) processes. For instance, for all milk types, 63°C/30 min and spray-drying preserved more elastase activity. In conclusion, processing differentially modulates protease activities in ruminants' milk. Understanding these differences is an important precursor for manipulating endogenous proteases to design dairy food products with high nutritional benefits. Further work is currently being conducted to determine how these proteases digest milk protein following processing.

- Core finding: 63°C/30 min and spray-drying preserved better protease activities in ruminants' milk.
- Industrial relevance: Milk processing could be used to design products with higher protease activities.

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# P7

## Quinoa protein enrichment with dry and wet fractionation

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Quinoa (*Chenopodium quinoa Willd.*) holds great importance for human nutrition due to its protein quality and resilience to climate change. This study aimed to test the feasibility of using dry and wet fractionation techniques or their combination to improve the protein yield while maintaining the functionalities of quinoa protein. Dry fractionation by size and density was performed after coarse milling in an impact mill, while wet fractionation was achieved using an alkali (pH 9.0) at room temperature. The quinoa protein concentrate (QPC) obtained following the wet fractionation was subjected to isoelectric precipitation at pH 4.5 to yield a protein isolate (QPI). The use of dry fractionation attained separation of different anatomical components of quinoa seed, resulting in a protein-rich fraction (355-710  $\mu\text{m}$ ) containing up to 24 % protein. The dry fractionation technique gave the highest protein yield (73.9%) while eliminating the use of water, compared to the yields of 56.9% and 47.9% observed in QPC and QPI from the wet fractionation method with a water usage ratio 10:1 (volume (mL) of water:gram of protein). Maximum protein solubility of 48.5 % was achieved for QPC and 71.6 % for QPI at pH 9.0. The combined dry and wet fractionation techniques bring additional benefits, including improved purity, yield, and the preservation of the functional properties of the starch and dietary fibre side streams. QPC is functionally, nutritionally, and ecologically desirable to develop novel plant-based foods.

- Core finding: Dry fractionation of quinoa yields maximum recovery of the product
- Core finding: Dry and wet processes attain high protein purity with less starch and protein damage
- Industrial relevance: High-value quinoa products obtained from economic and eco-friendly processes

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# P8

## Achieving the Heart Foundation sodium target for bread by substituting potassium chloride for salt

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Lowering sodium and increasing the potassium content of commonly eaten processed foods is a cost-effective way to reduce population blood pressure. Sodium intake in NZ is ~40% above the recommended intake and bread is the major source. This study aimed to test the consumer acceptance of lower sodium bread by replacing salt with potassium chloride (KCl) in white bread to achieve the Heart Foundation sodium target <380mg/100g. The project was conducted by an initial pilot sensory evaluation of bread (n=8 samples) with sodium reduction up to 80% (w/w) and a scaled up sensory evaluation study (n=49 participants) on the consumer acceptability of two breads with reduced sodium and two breads with potassium replacement. Results showed the highest level of sodium reduction based on overall acceptability was 50%. Consumers showed no significant preference for appearance, colour, aroma, and texture among all samples. However, significant differences were detected in flavour and saltiness. Bread sodium levels well below the Heart Foundation target of <380mg/100g were acceptable. Sodium reduction rather than substitution with potassium chloride may be the preferred strategy for salt reduction in bread.

- Core finding: Salt reduced bread preferred by consumers over substitution with potassium chloride
- Core finding: Bread sodium levels well below Heart Foundation target appear acceptable to consumers
- Industrial relevance: Greater industry commitment to salt reduction in bread is needed to support health

Affiliations: University of Auckland

# P9

## Indigenous meaning of food provenance

Authors: Chetan Sharma, Damir D. Torrico, Lloyd Carpenter, and Roland Harrison

This work reviews the concept of *provenance* from both contemporary and traditional aspects. It considers how provenance is operationalized in the modern paradigm. Guided by this, it discusses the meaning of provenance from an indigenous and non-indigenous rational. In this review work, the roles of alternative economic practices, education system, and socio-cultural norms have been found to be emerging factors that resist the framing of provenance in geographical boundaries and certifications. Informed by this, this review discusses the provenance from above and beyond the spatial dimensions of territory and compares this concept with *terroir* in the specified conditions of Aotearoa New Zealand. The incorporations of indigenous meanings and conceptualizations of *belonging* into provenance are explored in this review. Besides, applications of these concepts that benefit producers, as well as consumers, are discussed, using the *ngā tikanga* Māori/Māori culture as a case study. The review offers a comprehensive collection of research material with emphasis on a variety of fields including anthropology, economic geography, sociology, and biology, which clarifies the meaning of provenance in alternative food systems. This review also questions the current practices of spatial confinement by stakeholders and governments that are currently applied to the concepts of provenance in foods. We found that provenance is multifaceted from an indigenous perspective and needs support from multispecies ethnography to infuse *telos*, *terroir*, social and cultural dimensions in operationalizing its cores.

- Provenance is multifaceted and the concept of localness should not be confined to geographic limits.
- Indigenous meaning of provenance provides strong *alternatives* to the traditional food production system.
- In the immediate context, businesses should operationalize *tūrangawaewae* instead of *terroir*.

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# P10

## The implications of COVID-19 on Chinese consumer preferences for lamb meat

Authors: **Scott C. Hutchings**<sup>a</sup>, Luis Guerrero<sup>b</sup>, Miranda Miroso<sup>c</sup>, Phil Bremer<sup>c</sup>, Damien Mather<sup>d</sup>, Enrique Pavan<sup>a,e</sup>, Talia Hicks<sup>a</sup>, Li Day<sup>a</sup> & Carolina E. Realini<sup>a</sup>

In the wake of the COVID-19 pandemic, it is critical for food exporters to understand the effect the pandemic has had on the preferences of consumers towards food. The aim of this study, a case study with lamb, was to determine if Chinese consumer attitudes towards a range of lamb attributes (such as animal origin, food safety, appearance, taste, price, brand), as well as their opinions of New Zealand lamb, have changed since the outbreak COVID-19, and if so how. 250 consumers in Shanghai and 250 consumers in Beijing were surveyed online in January 2019. The same survey was repeated online with another 250 consumers in Shanghai and 250 consumers in Beijing in November 2020 (~9 months after China's initial outbreak). Results showed that on average there were minimal differences in Chinese consumer ratings between January 2019 and November 2020 for the importance of different attributes when purchasing lamb and opinions of New Zealand lamb. Interestingly, subsequent cluster analysis of the data revealed that 360 consumers in 2019 and 146 consumers in 2020 assigned different ratings to importance attributes, while the remaining consumers in 2019 and 2020 assigned similar ratings to most importance attributes. This study therefore suggests that COVID-19 had little effect on Chinese preferences for New Zealand lamb, however highlights that survey design and the appropriateness of using rating scales should be carefully considered when questioning Chinese consumers.

- Core finding: COVID-19 only had a very small effect on Chinese consumer ratings for NZ lamb
- Core finding: A substantial proportion of Chinese consumers use a small scale range with Likert scales
- Industrial relevance: Questionnaire design must be carefully considered when questioning Chinese consumers

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# P11

## Cyanobacteria bioactives: Sustainable microparticles for broad-based immunity in plants

Authors: Chua, Alysha

Reliable access to inexpensive and nutritious food is a growing concern as the global population expands and the climate changes. Enhancing food security should not come at the expense of environmental damage and sustainable agriculture must be a central tenet as we move forward. Presently, cyanobacteria inoculants are used in sustainable agriculture programmes to enhance crop yields but have faced performance challenges under field applications because of poor bacterial survival and colonization rates. Agrochemical encapsulation offers several performance upgrades from live-cell inoculants as it encapsulates the cell-exuded bioactive metabolites within a protective shell, which gets released in a controlled manner. This slow-release mechanism not only prolongs the protective bioactive effect but also reduces the dosage effect required for efficacy. *Nostoc muscorum* is the cyanobacteria model organism and our research has shown that its exudates can prime plants to acquire enhanced resistance against acute heat stress. Extensive screening using mutant *Arabidopsis* strains identified proline as the primary active ingredient responsible for this beneficial effect. This has important implications as proline is an effective protective agent across multiple stresses (e.g. salt, heat and pathogens) so plants can develop 'broad-based immunity' against multiple stress types. Instead of relying on genetic modification or laborious plant breeding, these slow-release proline microspheres can be potentially scaled to any type of plant and is not limited to a select species. Early prototypes of proline microspheres with poly(lactic-co-glycolic acid) as the encapsulation matrix has been generated and await further testing on their efficacy.

- Core finding: *Nostoc muscorum* exudates suppress stress-induced programmed cell death in plants
- Core finding: Identification of proline as primary stress-suppressing exudate in *Nostoc muscorum*
- Industrial relevance: Slow-release proline microspheres to inoculate plants for broad-based stress immunity

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# P12

## Milk protein interaction with black currant polyphenols and the effect on polyphenol bioavailability

Authors: **Maneesha S. Mohan**, Caren Meyn Alvarez, Iresha Matiwalage, Subha Sasidharan, Philip Wescombe

Black currant contains a variety of polyphenols including rutin, cyanidin-3-rutinoside, dephinidine -3-rutinoside. Polyphenols are associated with many health benefits owing to their antioxidant and anti-inflammatory properties. However, polyphenols are susceptible to rapid degradation and low bioavailability during digestion. Milk proteins bind polyphenols and are slow to digest indicating the possibility of designing effective milk protein based delivery systems for polyphenols. Our study evaluates the effect of the interaction of black currant polyphenols with milk proteins on their bioavailability. We studied the binding efficiency of black currant polyphenols associated with milk proteins, and conducted *in-vitro* digestion studies to understand the bioavailability of polyphenols during 2 hours gastric phase (pH 2, pepsin) followed by 3 hrs intestinal phase (pH 8, pancreatin) digestion. More than 75% of the bound polyphenols in the milk-black currant samples associated with the casein protein fraction in milk. *In-vitro* digestion studies indicated rapid reduction of the polyphenolic content released from the black currant extract sample on acidifying for gastric phase digestion. Although the polyphenolic content of milk-black currant samples also decreased on acidifying in the gastric phase, the proteins gradually released more polyphenolic content as the gastric phase progressed (first 60 min). Both black currant and milk-black currant samples showed prolonged polyphenolic release during the intestinal phase of digestion. Overall, milk protein and polyphenol interaction affected the bioavailability of polyphenols in black currant samples. This study provides impetus to further analyse the structural interactions of polyphenols with milk proteins, for designing milk protein based delivery systems for polyphenols.

- Core finding: More than 75% of the protein bound polyphenols in the milk-black currant sample associated with the casein protein fraction.
- Core finding: Interaction of milk proteins with polyphenols affected the bioavailability of polyphenols in black currant samples during *in-vitro* digestion.
- Industrial relevance: This study paves way to future studies on the possibility of using milk protein based delivery systems to improve the bioavailability of naturally available polyphenols from NZ fruits and berries.

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# P13

## Encapsulation of Mānuka Essential Oil in Yeast-Derived Microcarriers for Enhanced Thermal Stability and Antimicrobial activity

Authors: Shanshan LIU, Meihan TAO, Kang HUANG

Foodborne pathogens present in contaminated foods are recognized as a considerable burden for human health and socioeconomic development. Mānuka essential oil (MEO) exhibits antimicrobial, antiparasitic, photo-protective and some medicinal effects. However, limitations associated with the use of MEO, such as volatility, instability in complex biological systems, and only being effective at high doses, have significantly affected its large-scale applications in the food and agricultural industry. In this study, we propose to use a rapid and non-thermal vacuum infusion method to facilitate the encapsulation of the MEO in yeast cells. The ATR-FTIR spectra and confocal images demonstrated the success of MEO encapsulation. And the results show that yeast microcarriers significantly improve the thermal stability by 50%. The *in-vitro* release assay suggests the release kinetics of MEO from the microcarriers, demonstrating the control release function of the carrier. The antimicrobial activity of the encapsulated MEO was evaluated by incubation with *Bacillus cereus* with and without the presence of organic content (COD = 1000 mg/L). The results suggest that the encapsulated MEO can inactivate 4 log CFU/mL of bacteria after 1-hour treatment, regardless of the presence of organic content, while the non-encapsulated MEO at an equivalent concentration only achieved less than 1-log reduction in the presence of organic content. In summary, this study reveals the potential of cell-based encapsulation of MEO for antimicrobial treatments of foodborne pathogens in complex food and agricultural systems.

- A vacuum infusion method is used to facilitate the encapsulation of MEO in yeast.
- The yeast microcarriers improved the thermal stability of MEO.
- The encapsulated MEO exert enhanced antibacterial activities.

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# P14

## Nutritional and sensory quality of powders from pea cooking water (*Liluva*)

Authors: Luca Serventi, Weijun Chen, Hoi Tung Chiu

Consumers are demanding sustainable, plant-based food. Governments are encouraging circular economy. Therefore, upcycling the processing water of food manufacturing can be a solution. *Liluva* is the water left after soaking and boiling of legumes such as peas. It contains protein, fibre, minerals and phytochemicals. Nonetheless, the low solid content (about 5%) limits its applications. This study tested the effect of freeze- and spray-drying on the nutritional and sensory quality of pea cooking water. Neither freeze-drying, nor spray-drying affected the protein profile of pea cooking water, as shown by the SDS-PAGE gels (peptides) and the HPLC results (amino acids). On the contrary, the physical structure changed after drying. The Mastersizer analysis depicted reduced particle size in the reconstituted spray-dried powder, likely due to pressure. On the contrary, the slow freezing resulted in larger particle size. Smaller size was indicated as the main factor in the lighter colour of the spray-dried powder. Nonetheless, sensory analysis of sponge cake (made with *Liluva* in replacement of eggs) showed no significant difference between the original liquid and the reconstituted powder. It was concluded that drying of *Liluva* maintained its nutritional quality with marginal impact on the physicochemical properties.

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# P15

## Impact on Human Health of Microplastics in the New Zealand Diet

Authors: **Jeane Nicolas**<sup>a</sup>, Dr. Olga Pantos<sup>b</sup>, Dr. Sally Gaw<sup>c</sup>

Microplastics are an emerging area of concern with a number of studies now reporting their occurrence in different environments and matrices and this raises the question as to whether microplastics present a food safety risk. It is expected that plastics pose a low health risk to humans because they are biologically inert. However, hazard and risk of contamination of plastics due to manufacturing process, environmental exposure to chemical contaminants is unknown. The levels of microplastics and its associated chemical contaminants will be determined in a range of food categories, including wild food. The key to establishing whether ingested microplastics present a toxicity concern through food is to determine their properties once consumed and whether there is appreciable systemic uptake and metabolism of plastics. *In vitro* bioavailability studies will assess the absorption rates of microplastics (labelled, virgin and aged-plastics, and pristine particles) and their contaminants through the human gut. Having an understanding of what the levels of microplastic are and potential mitigation steps would advance public health in reducing exposure through the diet. Additionally, New Zealand's food-based export industries and economy are particularly vulnerable to microplastic contamination as this could result in a food safety risk, potential yield loss, and could have potential trade implications. This research will gain valuable knowledge that will contribute to assess the risks microplastics in food may pose to human health and key export industries for New Zealand, while also making a significant contribution to international microplastic research.

- Core finding: A method will be developed to extract microplastics from different food matrices.
- Industrial relevance: Primary industries could be negatively impacted due to microplastic contamination.

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# P16

## Rheological characterization of microalgal biomass influenced by high pressure homogenization as a structure-enabling process

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Microalgae biomass has a high nutritional profile that has potential to be incorporated into food for fortification with simultaneous modification of the structural properties. High pressure homogenisation (HPH) is a mechanical processing technology that has potential to modify the functionality of different food systems. This study investigated the effect of HPH at 300, 600, and 1500 bar as a structure-enabling process to modify the rheological and microstructural properties of three microalgae species, *Arthrospira platensis*, *Nannochloropsis* sp., and *Isochrysis* sp. Both treated and untreated microalgal suspensions showed deviations from the Newtonian behaviour and indicated shear-thinning behaviour. Examination of the microstructure showed varying degrees of cell disruption. HPH clearly disrupted the cells of *A. platensis* and *Isochrysis* sp., which led to the increase in viscosity and exhibited possible network formation based on particle size distribution and microscopy analysis. In contrast, *Nannochloropsis* sp. displayed minimal response to HPH with least observable cell disruption and negligible change in viscosity. This study shows the potential of high pressure homogenization as structure-enabling process to alter the rheological properties of algal suspensions that could be tailored to suit specific food product applications. Further study on this effect on nutrient bioaccessibility and digestibility needs to be conducted.

- Core finding:
  - Cell disruption resulted to increased viscosity of selected microalgal suspensions.
  - HPH had minor impact on altering rheology of *Nannochloropsis* sp. suspension.
- Industrial relevance: HPH can alter rheological properties of algal suspensions for tailored food products.

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