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Features

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SOUTH AFRICAN ASSOCIATION for FOOD SCIENCE & TECHNOLOGY

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message from the SAAFoST president

Dear readers

January 2014 heralded a new Council and new Branch committees. As always, there is a mix of old and new serving members – and this is one of the important aspects of continuity. It has become apparent that, although SAAFoST as an organisation is still incredibly relevant and well-supported, it is being challenged to find ways of communicating effectively in this modern era of competing media. We aim for some "thought-time" in our current members and in the yet-untapped young generation who are constantly buffeted by a storm of mobile phone calls, Webex conferences, e-mails, SMSes, WhatsApps, Tweets and Facebook notifications (to name a few!). We are certainly not alone in this and an important task for the new Council and committees is to come to terms with ways of reaching out to be heard and valued by our industry. The question is not just "How?" but also "What?". It is a good time for us to reflect on SAAFoST's inherent blueprint. We need to know who we are, what we are here to do and how we add value, and then to find ways to communicate this convincingly to elicit participation. To this end, the current Council will be setting up a day of strategic deliberation to encapsulate much of this thinking and to ensure that we understand the roots of our past, where to grow into the future and how best to get there.

In this era of time competition it is becoming quite apparent that many other non-profit organisations suffer the lack of event attendance and support of efforts due to time pressures in their members' working lives – and to monetary constraints of an ailing world economy. The option for us to collaborate and support closely affiliated organisations within the food industry is a sensible, symbiotic strategy to add value in our industry. Fragmented communication and calendars of events that clash are outcomes of a lack of co-operation that leads to frustrated efforts of these various bodies. If I recall correctly, there were at least nine events that were held in the month of September in 2013 that effectively competed for members' time and money. The challenge for us in 2014 is to reach out and try to leverage off each other.

SAAFoST not only presents a stage for scientific communication but also a podium to impassion our members with enthusiasm and vision for the exciting world of Food Science and Technology. It is a place where we can discover just how much we need each other, even in the competitive world of business.

Kind regards

Ryan Ponquett
SAAFoST President 2013–2015

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SAAFoST
SOUTH AFRICAN ASSOCIATION for FOOD SCIENCE & TECHNOLOGY

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regulars

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note from the editor

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The Postgraduate Showcase articles that feature regularly in **FST** are testament to some of the most interesting and relevant research being conducted in the Food Science and Technology arena in South Africa – strong, research-based studies that address the needs of local communities as well as industry. Industry can be proud of the quality of this research and the two articles featured are no exception. The first looks at the antioxidant effect of Maillard reaction products in a lipid-rich model system (Vusi Mshayisa), while the second describes the usage of rooibos tea extract as a natural antioxidant in commercial *droëwors* to improve its oxidative stability (Maxine Jones).

Staying with local topics, the lead feature in our issue is by Professor Jeanine Marnewick, who considers the scientific studies indicating the unique and important contribution to our current knowledge about the health aspects of rooibos tea, concluding that the body of evidence shows that rooibos could be considered as an innovative strategy to impact non-communicable diseases in South Africa and on the African continent.

The photo montages that make up the SAAFoST Branch News pages highlight the interesting functions being held all over the country and, hopefully, encourage readers (as SAAFoST members or visitors) not to miss the next event. If you are not a SAAFoST member, I recommend that you check the SAAFoST website (**www.saafost.org.za**) regularly for news about upcoming events. Should you have a topic you feel is suitable for a meeting, please contact the relevant Branch Chair.

Tricia Fitchet
Editor

Irene Burke (SAAFoST) and Shay Campbell at the Northern Branch year-end function.

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Rooibos:

a complementary approach to fighting chronic disease

By Professor Jeanine L Marnewick

Jeanine has a PhD in Biochemistry and is Research Professor at the Oxidative Stress Research Centre, Cape Peninsula University of Technology (CPUT).
Jeanine's main research focus for the past 16 years has been on oxidative stress-induced diseases/conditions and chemoprevention. The Oxidative Stress Research Centre is the only research centre focusing on the specific role that oxidative stress may play in the development of many important diseases. During 2007, she and her team completed the first rooibos clinical intervention study on adults at risk of developing heart disease, a groundbreaking first in the world. She has authored/co-authored many peer-reviewed journal publications, book chapters, international and national conference presentations, and lay publications.

According to World Health Statistics 2012 (a World Health Organization annual compilation of health-related data for its 194 member states), 63% of the estimated 57 million global deaths in 2008 were due to non-communicable diseases (NCDs), by definition diseases that are non-infectious and non-transmissible among people (WHO, 2012). NCDs disproportionately affect low- and middle-income countries. The WHO estimates the burden of NCDs in South Africa to be two to three times higher than in developed countries (WHO, 2008). The four main types of NCDs include cardiovascular diseases (CVD), cancers, chronic respiratory disease and diabetes, and they contribute to the most deaths caused by NCDs (WHO, 2012). The costs of death and disability globally are rising and causing an increased burden on our national and world economy. Today, costs, both direct as a result of treatment and indirect created by loss in productivity because of NCDs, are in the region of $1,3 trillion and may increase to $4,2 trillion in the next 15 years, with CVD cost to the South African economy exceeding R8 billion a year (CDC, 2008). In 2011, South African Health Minister Aaron Motsoaledi remarked when addressing the first Global Ministerial Conference on healthy lifestyles and non-communicable diseases in Moscow that "South Africa's healthcare model needs to shift from being hospi-centric to more preventative if the country is to win the fight against the burden of diseases" (**www.mg.co.za/article/2011-04-29-motsoaledi-calls-for-more-emphasis-on-disease-prevention**).

It is clear that the increasing burden in South Africa calls for further impactful innovative strategies to combat this trend. The WHO Global NCD Action Plan 2013–2020 includes a 25% relative reduction in premature mortality from cardio-vascular diseases, cancer, diabetes or chronic respiratory diseases by 2025 (**http://www.who.int/nmh/en/**). The majority of chronic diseases can be prevented or ameliorated by shifts in our lifestyle, such as making certain dietary changes. The focus on health benefits from food/beverages or specific dietary components such as phytochemicals has never been so strong and increasing the availability of health-promoting foods/beverages will help to ensure a healthier nation.

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Phytochemicals are non-nutritive plant components that possess antimutagenic and anti-carcinogenic properties. During the past few decades, the role that these dietary phytochemicals play in human health has been extensively investigated.

Scientific evidence has revealed that a flavonoid-rich diet may offer a strategy for the prevention of important lifestyle diseases where oxidative stress and inflammation play a role. Depending on the type of fruits, vegetables and beverages (specific teas, red wine, herbal teas) that one consumes, the daily intake of flavonoids can range between 50 and 800mg (Pietta, 2000). Based on the five-a-day concept and other dietary recommendations, a study using data from between 1983 and 2000 determined the average adult South African dietary total antioxidant capacity (TAC) and reported that the South African population only consumes an estimated 50% of the TAC per day, with beverages being the main contributors (47,8%) (Louwrens *et al.*, 2009). Strategies to ensure increased intakes of flavonoids could therefore include the addition of tea and/or herbal teas such as rooibos and honeybush to the diet as a "health boosting" or disease preventing option.

To date, only a small number of clinical interventions to evaluate the health-promoting and/or therapeutic properties of rooibos have been done specifically addressing NCDs and/or risks. A small (n=10) human study in the late 1970s reported on the effect of rooibos on iron absorption (Hesseling *et al.*, 1979). No detrimental effect on iron absorption was shown after the subjects had consumed traditional/fermented rooibos (200ml containing milk and sugar) when compared with the control group consuming water. Subsequently, a more recent study published in 2005 confirmed these results that the intake of 200ml of traditional rooibos (with milk and sugar) per day for 16 weeks by schoolchildren did not have any adverse effects on their iron status (Breet *et al.*, 2005). This was confirmed in another study in 2011, as a secondary objective where consuming six cups of rooibos daily for six weeks were shown not to affect the iron status of adults at risk for developing CVD (Marnewick *et al.*, 2011). The serum iron, ferritin, transferrin, TIBC and % Fe saturation were determined to assess the iron status of the participants. No significant changes in these biochemical parameters were recorded after completion of the rooibos and control study periods. It was concluded that the consumption of rooibos did not adversely affect the iron status of this study population when taking into account the habitual dietary composition and genetic variation in the HFE gene affecting iron absorption.

To consider the question whether rooibos flavonoids are physiologically relevant antioxidants in humans, thought has

to be given to their bioavailability. In spite of rooibos flavonoids' low bioavailability, an increasing number of studies are reporting very promising *in vivo* activities derived from human studies. In 2010, Persson and co-workers reported on the cardiovascular protective properties of rooibos. This study investigated the effects of rooibos (and other teas) on the angiotensin-converting enzyme (ACE) and nitric oxide (NO) in 17 healthy volunteers as a result of previous reports suggesting tea to reduce cardiovascular mortality. The volunteers (non-fasting) consumed 400ml rooibos infusion, with venous blood collected before and at various time periods after the consumption. Results showed rooibos to inhibit ACE activity significantly after 30 and 60 minutes. No significant changes were shown for NO levels nor blood pressure or heart rate at the various time points. The authors pointed out that previously protective effects displayed by the rooibos could not only be ascribed to the polyphenols' antioxidant actions, but that ACE inhibition should be added as another mechanism, specifically where cardiovascular disease is concerned. Soon hereafter, another study reported on the modulating effect of rooibos in adults at risk of heart disease (Marnewick *et al.*, 2011). This study investigated the effects that consuming fermented rooibos could have on oxidative stress and cholesterol levels in the adult participants. Forty participants (26 females, 14 males) consumed six cups (one cup constitutes one tea bag steeped in 200ml freshly boiled water for five minutes) of fermented rooibos per day for six weeks followed by a crossover control period. Fasting blood samples from this study did show a positive modulation of the lipid profile of the participants with the consumption of rooibos resulting in a significant decrease in serum LDL-cholesterol ("bad" cholesterol) and triacylglycerols, while also significantly increasing the HDL-cholesterol ("good" cholesterol) levels, possibly ascribed to the actions of the rooibos polyphenols. In addition, consuming the daily six cups of rooibos also improved the oxidative stress status of the participants as shown by the significant reduction in oxidative lipid damage as well as the significant increase in the important endogenous antioxidant, glutathione (GSH) levels, with a resultant increase in the GSH:GSSG ratio, both relevant to heart disease. Thus, to date, two studies have reported on the cardiovascular protective properties of rooibos.

In 2007, Nikolova and co-workers reported on the antioxidative effects of rooibos on workers occupationally exposed to lead. Seventy-five male workers consumed either rooibos or a placebo, where after several biochemical parameters were measured in the blood. Consuming rooibos increased GSH levels by 47,8% and also caused significantly decreased plasma MDA (oxidative lipid damage marker) levels, hereby positively modulating the antioxidant indices. As a secondary objective, plasma samples from the Rooibos & Heart Study (Marnewick *et al.*, 2011) were also investigated for rooibos's properties to alleviate stress. In this regard, Schloms *et al.* (2013) showed rooibos to change the cortisol:cortisone ratios in the plasma significantly, suggesting a role for rooibos in maintaining normal steroid levels, a factor very important when managing stress-induced conditions. In the past few years, using animal and *in vitro* models, scientists have also reported on the possible modulating effect that rooibos (and certain of its compounds) has on diabetes, another important NCD. These and other encouraging results definitely warrant more well-designed and controlled clinical intervention studies to elucidate the possible health-promoting properties of rooibos further.

As the popularity of rooibos increases across the world, an interest in the health-promoting properties and substantiation of anecdotal health evidence will also increase. Results from scientific studies conducted over the past years definitely make

Photo credits: Clive Von Metzinger

a unique and important contribution to our current knowledge about the health aspects of this proudly South African herbal tea. This body of evidence definitely warrants rooibos to be cautiously considered as an innovative strategy to impact non-communicable diseases in South Africa and on the African continent.

May rooibos become our own "elixir of life" in South Africa. *À votre santé* – To your health!

Photo credit: SA Rooibos Council

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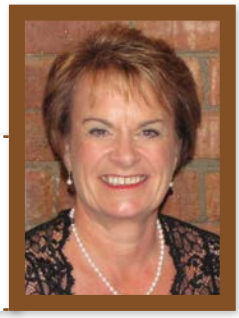
Chocolate trending

By Rosie Maguire, owner of In Essence



In Essence represents a number of overseas flavour houses (including Synergy Flavours) that have extensive expertise in the area of sweet and savoury flavours. *It is also the South African representative for Innova Database that tracks global food launches and identifies upcoming trends.*

Worldwide, demand for cocoa and chocolate products is increasing with strong growth in Asia, India and China. Globally the confectionery chocolate market is worth $102,3 billion (Euromonitor). Chocolate consumption is led by the Swiss who eat on average 11,9kg chocolate per annum. The Irish are the next biggest consumers (9,9kg/year) followed by the British (9,5kg/year) (Leatherhead Food Research). Manufacturers have identified huge potential to increase chocolate sales in emerging BRICS economies. Currently China consumes 1,2kg (Mintel), Brazil 2,5kg (LFR) and India 0,7kg (Rabobank) per person per annum.

The South African market is currently valued at R5,03 billion (Frost & Sullivan). Chocolate is viewed as an affordable luxury and sales are being driven by increasing disposable income and the growing middle class. The mass market is dominated by Mondelez, Nestlé and Tiger Brands. There is growing interest in premium and local artisanal offerings.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It's all about the bean

Sustainability of supply is one of the most pressing problems affecting the industry. Most of the world's cocoa is grown by millions of smallholder farmers who are facing challenges with farm productivity, bean quality, pests and disease. Many are changing to more lucrative and less tricky crops such as rubber. These issues are threatening the stability of the entire cocoa supply chain.

Prices are expected to soar in 2014 as the current crop is forecast to fall far short of requirements.

Major producers of cocoa powder and chocolate are focusing efforts on empowering and educating cocoa farmers and ensuring transfer of key technologies and effective collaboration between farmers and manufacturers, governments and NGOs. Fair trade certification is gaining popularity. Genetic research is focused on selective breeding, disease resistance, yield, genetic identification of beans, and flavour.

Cocoa is grown in a belt of subtropical and tropical countries within 20° of the equator. Whilst the biggest producers are situated in Ivory Coast and Ghana, significant quantities are grown in South America and Indonesia. There are big differences in the taste of cocoa from different regions and, in some cases, cocoa grown on a specific farm has highly desirable and unique attributes. It is, therefore, unsurprising that there is a growing trend for premium chocolate manufacturers to highlight the provenance of the cocoa used. There is a growing requirement to have tree-to-bean-to-bar traceability.

Healthy chocolate – an oxymoron?

Industry moves to reduce steadily the sugar, salt and saturated fat content of products are gaining momentum. This trend is also apparent in the chocolate industry where consumers want healthier options.

Sugar-free chocolate is a booming product category, in part because diabetes is one of the fastest-growing chronic diseases worldwide. Whilst this is not a new innovation, chocolate manufacturers are adopting different sweeteners to move away from the potentially negative effects of traditional polyols such as maltitol. Steviol glycosides are gaining popularity as a "natural" sugar alternative in chocolate and a bar with around 30% fewer calories can be produced. To replicate the function of sugar in chocolate, however, steviol glycosides also require a bulking agent, typically a fibre blend. Using fibre (depending on the level used) may allow a fibre claim but also adds significant cost. Other options for sugar replacement that are under review include fruit extracts, fructose and monk fruit. Since sugar consumption is currently highlighted as one of the major causes of obesity, sales of sugar-free and reduced-sugar chocolate can be expected to increase.

Fat is the principal source of energy in chocolate (40–50% of the kilojoules) and, as such, there is considerable interest in reducing the fat content of chocolate products. In 2012 Euromonitor estimated the market for reduced-fat chocolate to be worth $439,5 million and forecast 13,4% growth in 2013, with the majority of sales in the USA. Regulations restrict the amount by which a manufacturer can reduce the fat and still call the product chocolate. In the EU products containing less than 25% fat by weight cannot be labelled chocolate. The Codex Standard of Identity for chocolate states that chocolate must contain 35% total cocoa solids, of which no less than 18% must be cocoa butter. If a chocolate-like product does not meet the necessary requirements then the term "chocolate flavour" or "chocolate-type" is used with the potential perceived loss of quality by consumers.

Chocolate is also under the spotlight due to the saturated fat content. In the UK Nestlé will remove 3 800 tons of saturated fat from over a billion Kit Kat bars per year by reformulating the recipe. The reformulation has taken three years and has been achieved by changing the fat in the wafer filling.

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Consumers are becoming aware of the potential health benefits of the antioxidants found in cocoa. Last year, consumer perception of cocoa and chocolate as healthy received a major boost when chocolate supplier Barry Callebaut received EU Commission approval for its health claim submission on cocoa flavanols. The company is now able to use the health claim that "cocoa flavanols help maintain the elasticity of blood vessels, which contributes to normal blood flow." Scientific evidence showed that the daily intake of 200mg of cocoa flavanols supports a healthy blood circulation by helping to maintain the elasticity of the blood vessels. The claim can be used for cocoa beverages (with cocoa powder) or for dark chocolate providing a daily intake of at least 200mg of cocoa flavanols.

Game changer in hot climates

Due to the hot climate prevailing in markets identified for sales growth (such as India and Brazil) efforts to produce an organoleptically acceptable, temperature-stable chocolate are increasing.

Cocoa butter usually starts to soften at 28°C and, as a result, chocolate becomes sticky or runny at the ambient temperatures prevailing in hot countries. The product tends to stick to the wrapper and disintegrate when it is unwrapped. Previous attempts to obtain a temperature-stable chocolate generally involved substituting cocoa butter with high-melting-point fats. The resulting products often had an unattractive, waxy mouthfeel. There is growing focus on identifying alternative cocoa butter replacers that overcome this challenge. A recent study by M.H.A Jahurul *et al.* (*Journal of Food Chemistry* 2013.11.098 – In Press) has indicated

potential for a cocoa butter replacer comprised of mango seed fat and palm stearin that maintains structure at 37,5°C.

New research by the chocolate giants Nestlé and Mondelez (Cadbury) has addressed the technical problems encountered in tropical climates. Nestlé claims that its temperature-tolerant chocolate can withstand temperatures of up to 45°C. Adverse organoleptic effects are minimised as the technology involves the application of a "tropicalised shell". Their patent application claims that "when exposed to the temperature above the usual melting temperature of chocolate only the product core will soften and, above certain temperatures, even become liquid, but the shell will remain solid and thus the whole product will retain its shape". Mondelez's patent for temperature-tolerant chocolate relies on a re-refining step after the conching stage. The process shears sugar particles to produce a more continuous sugar matrix that reduces the number of fat-coated particles.

Into the future

"Hybridisation" is a current buzzword driving innovation across all categories. The strict definition of the term is "a thing made by combining two different elements", so a popular flavour such as chocolate can be successfully adapted to a seemingly unrelated category. In the USA PepsiCo recently launched a limited-edition Lay's wavy potato chip dipped in milk chocolate. And, for those bored with regular chocolate, the combination of chocolate and cheese found in Japan (Meiji white chocolate and cheese) and America (Aldi Cheddar with chocolate inclusions) has added a new flavour dimension to the category.

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The trend to sweet and savoury combination flavours has gained traction and popularity over the last 12 months. The confectionery category is no exception with sea salt, wasabi, Tabasco and chilli appearing in products paired with chocolate. I predict that more wacky flavour mixes will appear as companies strive to stimulate consumer interest. Whilst combinations such as bacon and chocolate may not necessarily find a huge following, it should be remembered that using chocolate in savoury foods dates from its origins in Mexico and is a key component of *Mole Poblano*. Keen to link chocolate to the health benefits of a Mediterranean diet, Spanish company Natra is developing a range of chocolates filled with olive oil, cheese and wine.

Due in part to a shift towards more sharing formats the "bite size" chocolate market is booming. The phenomenon is also being driven by an interest in portion control. According to Innova database in the UK, sales of bite-sized chocolates were worth GBP520 million in 2011–2012, with annual growth at more than 4%. This equates to around 14% of the total chocolate confectionery market.

Recent chocolate launches indicate that manufacturers are placing emphasis on texture to create new and exciting chocolate eating experiences such as Lindt Lindor Irresistibly Smooth milk chocolate. In the UK, Cadbury has launched range of "Marvellous Creations" where unexpected, yet familiar, inclusions such as gummi bears are enrobed in Cadbury Dairy Milk to give a unique organoleptic effect. Aero chocolate was first introduced by Rowntree (now Nestlé) in 1935 so "bubble" chocolate is not a new concept. Recently, however, other "bubble" chocolates have been launched, designed to "tickle the taste buds" and provide a lighter consumption experience.

In the words of Jo Brand, "Anything is good if it's made of chocolate." The challenge that industry faces lies in ensuring that chocolate retains its appeal as an affordable indulgent treat that can be incorporated as part of a healthy lifestyle.

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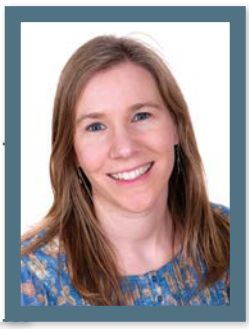
The market sweetens up

By Emma Gubisch,
Strategic Insight Manager,
Leatherhead Food Research



Emma is responsible for designing projects containing primary and secondary research to help to address clients' needs and deliver actionable insights.
Her expertise is in market research using qualitative and quantitative methodologies to understand the views of key audiences.

Plant-derived sweeteners, such as stevia, are expected to provide the main impetus for growth in the sweetener market in the coming years. However, as manufacturers work to create the right taste profile for stevia and wait for other plant-derived sweeteners, such as monk fruit, to obtain regulatory clearance, the artificial sweetener market still offers growth opportunities, in particular the sucralose and acesulfame-K markets.

The future is bright for sweeteners

With the spotlight currently on sugar and its reported impact on weight gain and rising obesity levels, the opportunities for sweeteners are clear. Consumers are becoming increasingly conscious of the amount of sugar in their diets, highlighted by recent research by Mintel showing that 37% of UK consumers claim to avoid sugar where possible in their diet. Signs that the

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global market for intense sweeteners has reacted to this increased demand for "healthier" sweetener solutions are already evident. By the end of 2013, the global market for intense sweeteners as additives used in the manufacture of food and beverage products was forecast to reach a value of US$1,27 billion, a figure which represents an increase of 2,8% compared with 2012. By 2017, global market value is expected to increase to almost US$1,4 billion, up by 9,7% from levels in 2013.

Figure 1: Global sales of intense sweeteners by value, 2012–2017

	2012	2013	2015*	2017*
Total global sales of intense sweeteners (US$ billion)	1,238	1,273	1,318	1,397

Source: Leatherhead Food Research
***Forecasts**

Laura Jones, Food Science Analyst at Mintel, said: "Much of the growth in the global sweeteners market is set to be driven by growing consumer concerns over sugar intake, whilst the development of more plant-derived sweeteners is also anticipated to benefit the market. The gradual demise of sugar yet desire for sweetened food and drink products, suggests good opportunities for intense sweeteners. Intense sweeteners offer a source of sweetness without the calorie contribution of sugar, an increasingly attractive proposition to consumers struggling to manage their weight."

The use of intense sweeteners in launches of food and drink products has grown over the past five years, from being used in 3,5% of all launches globally in 2009 to 5,5% in 2012, and this growth looks set to continue. Meanwhile, the global market for all sweeteners (intense and bulk) as additives in food manufacture – rather than sold to consumers at the retail level – was worth more than US$2 billion in 2012. Value sales have started to pick up again as the worldwide economic situation has improved, with the global market up by 3,8% from US$1,94 billion in 2010.

Plant-based sweeteners offer growth opportunities

Stevia has been quietly gaining traction in the market, usurping the traditional pecking order of more established sweeteners, due to regulatory clearance, improved tastes and textures and increased consumer buy-in and demand. Leatherhead Food Research's new report on intense sweeteners in conjunction with Mintel (**www.leatherheadfood.com/intense-sweeteners**) highlights theopportunity for such plant-based sweeteners to provide the main impetus for growth over the coming years. Indeed, while the value of stevia as an additive for use in food and beverage manufacture totalled US$110 million in 2013, Leatherhead Food Research forecasts this to grow to US$275 million by 2017.

In contrast, aspartame – while recently having been ruled safe for human consumption at current levels from the EFSA and currently accounting for a value of £280 million in 2013 – is forecast to drop to £210 million by 2017 as stevia, and blends of stevia and other sweeteners such as acesulfame-K, begin to take a greater share of the market.

In 2009, only 5% of food and drink products launched using intense sweeteners used solely plant-derived sweeteners (although a further 2% used a blend of artificial and plant-derived sweeteners). In contrast, in 2013, the share of plant-derived sweeteners jumped to 15% (with a further 3% using a blend of artificial and plant-derived sweeteners). Between 2011 and 2013, plant-derived sweeteners reached a high of 28% of launches in North America.

Figure 2: Types of intense sweeteners used in launches of "sweetened" products, global, 2009–2013

	% product launches with artificial intense sweeteners	% product launches with plant-derived intense sweeteners	% product launches with artificial and plant-derived intense sweeteners
2009	93	5	2
2010	90	7	2
2011	89	9	3
2012	84	12	3
2013	82	15	3

Note: 2013 data is for Jan–Sept 2013
Source: Mintel GNPD

The adoption of stevia across a greater range of categories, as well as its use in the reformulation of more mainstream products, backs Leatherhead's strong growth projections for stevia. Stevia extracts have been used in a number of leading food and drink brands, including those from Coca-Cola, Danone, PepsiCo and Starbucks.

"Stevia and other sweeteners, such as acesulfame-K, begin to take a greater share of the market"

The development of the next generation of stevia extracts, in particular rebaudioside D and rebaudioside X, set to be commercialised in early 2014, should encourage more brands to experiment with stevia. If the promises of these new stevia sweeteners – including their cleaner profile, which imparts significantly less bitterness than rebaudioside A – are realised, stevia should become more of a mainstream ingredient.

Artificial sweetener market remains strong

Breaking down the usage of intense sweeteners in new product launches shows that today, artificial variants, such as acesulfame-K, sucralose and aspartame, are still dominant. Due to its use in blends, acesulfame-K leads in launch activity; however, the share of products using acesulfame-K has gradually declined from 56% in 2009 to 49% of launches in 2013. Sucralose takes the second spot and its use has remained constant over the past five years, found in around 40% of all products launched with an intense sweetener. Aspartame comes in next; however, its share is consistently dropping year on year, going from being used in 40% of 2009 launches to 32% of 2013 launches. Categories still heavily reliant on artificial variants include sugar confectionery, desserts and ice cream, dairy products and carbonated soft drinks.

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The sucralose sector is now the largest sector within the global intense sweeteners market in value terms (34%), having overtaken aspartame in recent years and showing more potential for growth in some regions given its positioning as the most "sugar-like" of the artificial sweeteners.

For membership enquiries
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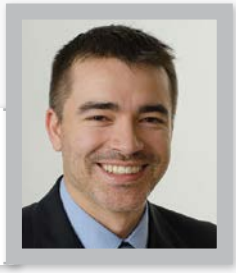
Photo courtesy of Salt of the Earth

Easy steps to less salt

By David Despain



David, an IFT member, is a freelance writer with a passion for good food combined with a good story. *He has a Masters degree in human nutrition and a Bachelors degree in English.*

Salt just works. No other single food additive can be said to have a use in nearly all prepared dishes. Salt gives and enhances flavour, masks off flavours, stabilises structure and texture, and preserves. Most important of all, salt nourishes – sodium and chloride, in the right amounts, are essential for sustaining life through roles that include helping to regulate fluid and electrolyte balance, pH and metabolism.

Summed up, you could say, we're all "salt-seeking creatures," as are all land-living vertebrates, because we're drawn to salt continually to replace what we lose on a daily basis. Before the advent of modern geology and industry, salt was one of the world's most sought-after commodities.

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Why then make the effort to reduce salt in foods? The oft-repeated statistic is that average sodium consumption is too high. Guidelines are largely based on the indication that as sodium intake decreases, so will blood pressure, and, thereby, so will the risk of cardiovascular disease and stroke. However, the recommendations have come under scrutiny in light of a 2013 Institute of Medicine (IOM) report acknowledging that there is little, if any, evidence of benefit for intakes below 2 300mg of sodium per day for the general population. At the root of the debate are data showing that sodium intake below 2 300mg might actually harm, rather than help, potentially because of compensatory mechanisms the body produces hormonally to maintain proper sodium–water balance. The report has led some scientists to argue that any recommendation below average consumption levels – at 3 400mg – is premature without additional evidence, and that efforts to lower blood pressure should include other components such as decreasing total caloric intake and increasing dietary potassium (found mainly in fruits and vegetables). Others argue that average sodium intake is still higher than it should be and that population-wide sodium reduction should continue as a health priority.

Notwithstanding ongoing discussions over ideal sodium guidelines and conflicting data, several government, public health and professional organisations have made it their objective to implement strategies to reduce sodium intake. The World Health Organization (WHO) goal is to reduce sodium intake to less than 2 000mg by 2025. The US Centers for Disease Control and Prevention (CDC) has also made sodium reduction a "key component" of its initiatives to control blood pressure and improve cardiovascular health. Most recently, Hypertension Canada announced that it is raising sodium recommendations to 2 000mg/day. Previously the organisation recommended 1 500mg per day for those aged 14 to 50, 1 300mg/day for those aged 51 to 70, and 1 200mg/day for those aged 70 and older.

The IOM's recommendation as a primary strategy by which to reduce population-wide dietary sodium is to mandate national standards for sodium content in foods and, as an interim strategy, to encourage food manufacturers and restaurant and food service operators voluntarily to reduce sodium in processed foods.

According to Mintel's Global New Products Database, there was an almost 115% increase in the number of

products with low-, no-, and reduced-sodium claims from 2005 to 2008. Although, from 2010 to 2011, the number of products launched with these claims decreased 5%, with only 2% of products making the claims in 2011, probably due to poor sales and sodium-reduction challenges or perhaps because food manufacturers are opting for a "stealth health approach" to sodium reduction.

Stealthy sodium reduction

Companies are finding a stealth health approach ideal because customers often perceive low-, no-, and reduced-sodium claims as a sacrifice of flavour. A survey conducted by the International Food Information Council (IFIC), for example, found that only 13% of consumers say they would choose a product with a "low-sodium" claim as compared to other front-of-pack claims or no claims. As David Freedman reports in the July/August issue of *The Atlantic* in an article titled "How Junk Food Can End Obesity", companies – including McDonald's – have had to learn hard lessons from past product launch failures, finding that consumers can be turned off by "healthy" marketing claims. Now McDonald's and other companies, reports Freedman, have opted to make their offerings healthier – with reductions to sodium, as well as fat and sugar – more quietly so as to not alarm consumers.

Consumer preferences for products that are high in salt are acquired over time, often since childhood, so a gradual approach to sodium reduction is critical for altering taste likings. Nestlé Switzerland is an example of a company that has successfully put a gradual approach into action, slowly reducing sodium, and allowing consumers to adapt their tastes for salt since 2005. By 2012, Nestlé reports, its products contained 14 043 fewer tons of salt. It has now announced a pledge to accelerate reduction of sodium across its brands globally. Through investment in new sodium reduction technologies, the company has committed to reducing sodium in hundreds of its high-sodium products by 10% in the next three years.

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Taking notice of these sodium reduction trends are the largest producers of salt, who are now offering clients a combination of technical expertise and product solutions for sodium reduction in foods. Food processors are taking a stepped approach to sodium reduction in food products. The vast majority of such changes is done in stealth with no packaging claims or announcements to indicate that the food product has been reduced in sodium. Gradual approaches to sodium reduction are often not met by one strategy alone, but often a variety, depending on the product. Fortunately, over the last four decades, food technologists have found various ways to reduce sodium content in foods.

The majority of step-wise approaches used by food technologists start with focusing first and foremost on making the most of salt's flavour in products.

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Focus on salt first

The first step to reducing salt in food products begins with maximising how salt in the product interacts with the tongue. An example is in snack foods, such as pretzels or tortilla chips, where tongue interaction occurs mainly on the surface of the product. That leaves opportunity for using different crystal sizes and shapes as found in varieties of Kosher salts, sea salts and specialty salts to increase the boldness of salt's flavour. This may seem counterintuitive since specialty salts are still pure sodium chloride; however, using a different salt product may provide the desired flavour characteristics while allowing less salt to be used.

In other applications where salt is best distributed throughout a food matrix, another option is to go with smaller, lower-density crystals. Standard salt crystals are being turned into free-flowing, hollow salt microspheres. The microspheres are produced using patented spray-drying technology and facilitated by gum acacia hydrocolloid as a processing aid.

While typical salt crystals range from 40 to 800 microns and are solid, these are consistently smaller at 20 to 200 microns depending on their grade. They are also hollow to maximise surface area relative to volume, allowing them to dissolve more rapidly, contributing to a salty taste more quickly upon impact on the tongue.

Substitute with potassium

Once having made the most of salt's impact on the tongue in an application, the practical approach is to replace extra salt with potassium chloride or combinatorial mineral salt substitutes. Because dietary potassium intake itself is shown to improve blood pressure, it is an ideal substitute for counteracting the effects of sodium.

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However, potassium chloride can bring potential problems of off-notes. The main issues associated with use of potassium chloride are a metallic aftertaste and a different mouthfeel. The solution is a potassium chloride blended with added flavour compounds that enhance saltiness and mask the metallic perception.

Colour it for kids

Developing all-natural solutions to stay with current trends of sodium reduction, while meeting client demands for clean labels, is not an easy task. However, one company has recently become creative in helping to lower sodium intake in children with a line of low-sodium sea salts enriched with vegetables and fruits (such as radish, carrot, apple, and lemon). The sea salts come in four vivid colours including yellow, red, orange and green. By colouring the salt with fruit and vegetable essences, it is possible not only to help kids and adults to eat low-sodium foods but, as a bonus, they can see how much salt to put on their food.

Bring on savoury

After using a variety of approaches to reduce the quantity of salt in a product, principally potassium chloride, the next step is to work on savoury notes to enhance salt's flavour. When looking for savoury note ingredients, an obvious choice is monosodium glutamate (MSG) and other glutamate-containing ingredients.

A line of nucleotides such as disodium 5' inosinate and disodium 5' guanylate are used to work in greater synergy with taste characteristics of foods using glutamates and other flavour-enhancing nucleotides.

When creating applications where a "clean label" is preferred, the task can be accomplished by adding glutamate-rich yeast and mushroom extracts, followed by notes of onion and garlic, as well as spices to give the product some heat. The objective is to provide a more complex flavour profile and, therefore, to fool the mouth.

Photo courtesy of McIlhenny Co.

Adding Tabasco sauce can elevate a product's flavour without increasing sodium content.

Give it some heat

Nothing enhances flavour like a little heat. When you remove sodium or fat, there is some flavour being removed. Since Tabasco has umami-like properties, you can remove any extra sodium because adding Tabasco will elevate the flavours of any dish as a whole without increasing the sodium content. The only time any salt is added to the product is simply for preservation purposes when peppers are ground. The ageing process is relied on to really develop the flavour.

Photo courtesy of Kikkoman Sales USA Inc.

Using soy sauce as an ingredient in products like beef sandwiches allows product developers to pump up the flavour without added salt.

Sauce it up

Soy sauce is used in a number of applications including sauces, soups, dressings, beef sandwiches, frozen foods, nut mixes and even tortilla chips. With soy sauce, food producers often don't need to add any more salt. For these reasons, says soy sauce can be expected to play a major role in helping to reduce sodium in a variety of food products.

Smoke it up

One company has a mission to help food producers to bring out the most of salt's natural flavour. It has eight different grain sizes to help food producers to round out flavour and texture, allowing for reduction in total salt used in a variety of applications. The smoked flavour offers an all-natural way to flavour salt. The gourmet smoked salts are produced one batch at a time using wood smoke from bark-free logs.

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Got milk permeate?

Dairy product solids, or milk-derived permeates, are also showing promise as salt enhancers in foods. The sensory properties that give permeate its salty taste are not yet known, and it is currently under investigation. In bakery products, it can be used as a one-to-one replacement for sweet whey powder and to assist in sodium reduction of biscuits, caramels and cakes.

Photo courtesy of Morton Salt Inc.

Using coarse sea salt as a topping provides a lingering saltiness and enhances the visual appeal of this caramel brownie.

No single sodium reduction strategy

Strategies to reduce sodium in a given product clearly vary depending upon salt's functionality in the product.

Roger Clemens, IFT President 2011–2012, summarised the various roles that sodium has in food products. He pointed out that salt is not only used to impart its own flavour and enhance or mask other flavours, but also for controlling water activity and growth and metabolic activity of microorganisms. So any reformulation often requires extensive pathogen testing. Salt is also necessary to control the growth of yeast or starter culture in products such as cheese and cabbage and to promote the development of gluten structure in bread. In meat products, salt supports several functions including water-holding, protein-gelation and fat-emulsification capacities. In ice cream, dough and pastries, salt also minimises ice crystal formation. In baked goods, sodium is also used in the form of sodium bicarbonate, or baking soda, for the creation of carbon dioxide bubbles that help with the expansion of dough and batter.

Given salt's multifaceted functionality, it should be no surprise that more research and innovation is necessary to overcome challenges. Salt is truly worth its salt.

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Measuring the sugar content of jams and sauces accurately

By Kylie Davis, Marketing Manager, Lasec SA (Pty) Ltd

Kylie has a strong technical background, having completed her Bachelor of Science Honours degree at the University of Cape Town. *She has spent a number of years at Lasec in technical sales and application support of key products and brands.*

The preservation principles relating to jam and sauce production are complex but generally involve the correct combination of acidity, sugar level and pectin content to ensure a satisfactory product.

High acidity prevents the growth of food poisoning bacteria and helps maintain the colour and flavour for most fruits. However, some moulds and yeasts can still grow at the high acidity and can spoil food. Sugar helps to capture and preserve the flavour, aroma, colour and qualities of various fruits. The sugar content is usually taken with a refractometer and is expressed as "brix".

A refractometer characterises fluids based on their refractive index – refraction occurs due to the change in the speed of light as it travels through a material of one density to another of a different concentration.
Light passes more slowly through media as the samples become denser or more concentrated. Therefore, refractive index is a unique, constant physical characteristic of pure substances, but its most common use is for calculating the concentration of dissolved substances in water. Measuring the sugar content of a substance (its brix) is a common application of refractometers and one that is particularly relevant as a quality control measurement of jams and sauces.

Measurements and mathematical error

Refractometry measurements strongly depend on the wavelength of light applied to the sample and the sample temperature. Standard refractometers use the wavelength 589,3nm and take measurements at 20˚C. While the wavelength is fixed, sample temperatures will vary (unless controlled) and significantly affect refractometry measurements.

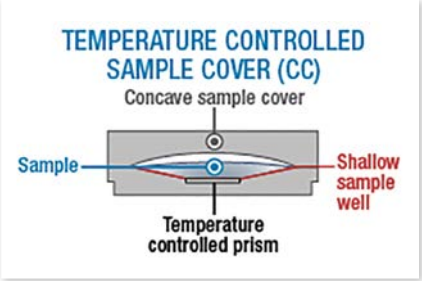
Liquids and solutions become less dense at higher temperatures, so light passing through higher temperature samples encounters fewer solute and solvent molecules; one would therefore expect that the refractive index of a sample at 25˚C would be slightly lower than at 20˚C. One way to compensate for temperature is to apply a numeric correction for temperature variations from 20˚C.

Reasonable numeric correction based on ICUMSA (International Commission for Uniform Methods of Sugar Analysis) correction tables work well for pure sugar and water substances where there is a linear relationship between refractive index and temperature change. However, the less pure one's dissolved substances become and the further the sample is from 20˚C (as is often the case with measurement of jams and sauces), the greater the potential for mathematical error.

Jams and sauces are heterogeneous samples with various components and do not consist wholly of sucrose and water, so they pose a challenge for correct measurement of sugar content with a refractometer. When measuring, it is important to ensure that the sample is as homogeneous as possible – this is achieved by simply ensuring that the sample selected is representative of the sample as a whole i.e. take a mix of sample from the top, middle and bottom of the tin or jar and ensure it is well mixed physically with a spoon or spatula before being applied to the refractometer sample prism.

Accurate brix measurement

Due to the heterogeneous nature of jams and sauces as samples, the ICUMSA mathematical refractive index correction mentioned earlier (and sometimes referred to as automated temperature compensation or automated temperature correction) is not sufficient or accurate as



jams and sauces are not pure substances and are often measured at temperatures much higher than 20°C, for which the refractometer is attempting to compensate mathematically. The most reliable solution for accurate measurement of brix (of non-standard samples that contain numerous dissolved solids) is to utilise a refractometer that can physically heat or cool the sample to precisely 20°C via peltier technology. Refractometers with electronic heating and cooling of both the presser (situated above the sample) and the sample well itself can greatly enhance temperature stability and speed of physically heating or cooling the sample to the required temperature to ensure accurate comparison between samples.

A sticky challenge

A further challenge is that samples are often very messy and sticky. Refractometer measurement accuracy is only as reliable as the cleanliness of the sample well. A flat, easy-to-clean prism design is an essential consideration for any food laboratory working with jams, sauces and sticky substances. A flat, low-profile sample well (with no corners or steep angles to trap sticky samples) avoids or reduces cross-contamination between samples and also requires less sample volume for accurate measurements.

In conclusion, sugar content is an important measurement when considering quality control of jams and sauces; however, there needs to be an understanding of the challenges to accurate measurement of these samples as heterogeneous matrix mixtures. Accurate measurement is only possible with selection of a homogeneous representative sample and the use of a modern refractometer equipped with a flat, easy-to-clean temperature-controlled prism.

Lasec supplies scientific and laboratory equipment in South Africa and sub-Saharan Africa. Contact kylie.davis@lasec.co.za or call 021 531 7504.

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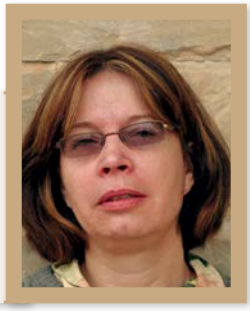
Food fortification and vitamin A analysis

By Andriette de Jager, Specialist Analyst, South African Grain Laboratory (SAGL)



Andriette has a broad academic background, which includes Natural and Social Science degrees, as well as an MBA from the University of Pretoria. *Her analytical experience is in the field of amino acids and vitamin analyses in food and related matrices. She has been involved in the South African maize and wheat flour fortification programme for the past decade.*

Food fortification as a cost-effective intervention

According to the World Health Organization (WHO), nearly two billion people suffer from malnutrition globally. This lack of key vitamins and minerals has the most devastating effect on children, infants and women of reproductive age. The mass fortification of staple foods with those key vitamins has proven to be the most cost-effective way of reducing these deficiencies. Many governments have implemented mandatory food fortification regulations in an attempt to improve the health of their populations.

In South Africa, it is mandatory to fortify staple foods, such as white and brown bread flour, with vitamin A, thiamine, riboflavin, niacin, pyridoxine, folic acid, iron and zinc. Arguably the most critical of these is vitamin A. A diet deprived of vitamin A increases the risk of disease and death from severe infections and can cause loss of sight. The fortified flour is purchased directly by the consumer, or bought by other sectors of the food industry to bake bread and – to a lesser extent – other baked products.

Quality control

A major challenge in the quality control of fortified foods is the homogeneous distribution of the fortificant in the target matrix. Additionally, vitamins such as vitamin A are light- and heat-sensitive, which can lead to a loss during the processing of the flour into other products.

It is therefore crucial to ensure that the flour used as ingredient contains the required level of vitamin A. Frequent testing of vitamin levels along the production process helps to ensure that a sufficiently fortified final product reaches the consumer.

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However, the determination of levels of specific vitamins in food products can be expensive and time-consuming for food producers, complicating their quality control processes. An example is the method of choice for the determination of vitamin A, which is High Performance Liquid Chromatography (HPLC) with an average cost of USD70 per sample and a relatively long analysis time.

Comparative method

As an alternative for the analysis of vitamin A in premix and wheat flour, a test kit has recently been developed that consists of a portable measuring device, a fluorometer and ready-to-use reagent vials. A flour suspension (extract) is injected into these vials, which are then used as cuvettes. The measuring device detects the fluorescence of vitamin A in the vial as retinyl equivalents (RE) per litre. With the test kit, vitamin A analysis in flour can be carried out within a few minutes, even at the production site. The test kit analysis was compared with the traditional HPLC determinations.

For the study, 58 different flour samples from Africa, with unknown vitamin A concentration, were analysed using both methods. As a control, the fluorescence effect of

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four different unfortified flour samples was measured and used as a blank value. The flour samples were extracted using water and injected into the ready-to-use reagent vials and measured in accordance with the supplier's instructions. For the HPLC, samples were saponified and then extracted. The vitamin A (as retinol) was then analysed by the HPLC using a UV detector.

The fluorometric measuring device was able to measure the vitamin A content of the 58 flour samples in the fortification range of 0,5–63,4mg RE/kg. The correlation between the test kit and the HPLC vitamin A results was well acceptable with a Spearman coefficient of $R^2 = 0,97$. Using the Bland-Altman analysis, it was confirmed that the HPLC and fluorometric results differ on average by 0,1 mg RE/kg and 98% of samples fell within the expected range.

It was observed that in the lower range of 0,5–1,0mg RE/L intrinsic flour fluorescence leads to slight over-estimation. Therefore it is recommended to set the detection limit of the test kit to 1mg RE/kg flour (1 000mcg RE/kg). Additional experimental work is planned to address this challenge and to improve the limit of detection.

In summary, this test kit could be used as a fast alternative to HPLC for the determination of Vitamin A in highly fortified flour.

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Product reformulation

By Tim Hutton, Emma Hanby, Sarah Chapman, Rachel Gwinn and Charles Speirs of Campden BRI

Tim is Editorial and Reprographics Manager at Campden BRI where he has worked for 25 years, initially as technical information officer but, increasingly, in writing about various aspects of food production.

There is much pressure on manufacturers to reformulate their products to reduce salt, sugar, and total and saturated fat. One of the major drivers for this is health concerns. Manufacturers are also looking to reduce their use of additives (and provide "clean label" alternatives) in response to perceived market requirements. Overall, this poses significant problems for the manufacturer. In addition to the complex issues of taste, flavour and overall consumer acceptability, those involved in product development must take into account microbiological activity in the reformulated product, particularly when it affects product safety, as well as effects on processing.

One of the issues is the question of degree. When reducing salt, fat or sugar levels, for example, should a manufacturer go down the route of reducing them by a significant margin or is it best to reduce by stealth, so that changes are more easily accepted by the consumer? This article outlines some of the considerations surrounding product reformulation.

Health issues

Excess weight is a major risk factor for diseases such as type 2 diabetes, cancer and heart disease. Yet, reducing calorie levels is a complex issue with no universal remedy. While portion control has been suggested as a potential solution, it is unlikely to be an acceptable solution for all consumers.

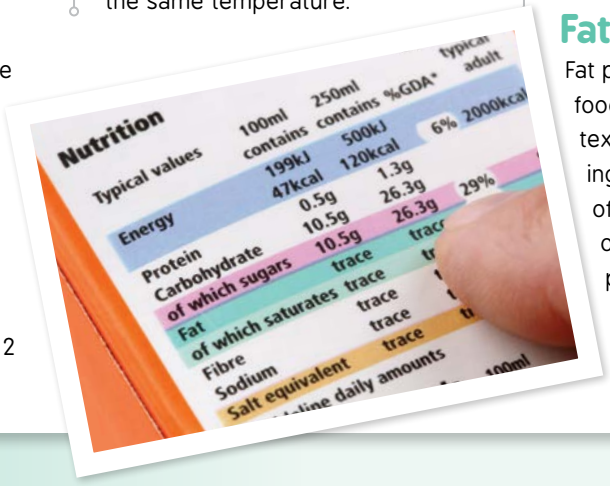
Safety issues

Two ingredients that specifically affect microbiological growth are salt and sugar – and both have been extensively used for their preservative properties.

Salt and sugar inhibit the growth of microorganisms at increased concentrations by reducing the water activity. Water activity (a_w) is defined as the ratio of the partial pressure of water in the atmosphere in equilibrium with the substrate, compared with the partial pressure of the atmosphere in equilibrium with pure water at the same temperature.

The a_w of pure, distilled water is 1.0. The minimum a_w required for the growth of bacteria is 0.9; for yeasts and moulds it is 0.6. In products such as jam, sugar binds with water, causing the water activity to fall below 0.85. This inhibits most microbial growth except yeasts and moulds. Reducing sugar content will increase a_w and so potentially increase the range of microorganisms that are able to grow.

This has implications for safety assurance plans since a critical control point – water activity – will have been changed. For products like jam it also raises the conflicting priorities faced by industry: attempts to assure product safety, maximise shelf life and minimise waste by using sugar as a natural preservative versus the drive for diet, health and clean label by using sugar alternatives.



Fat

Fat provides many functions in food, including flavour and texture. There is much work being undertaken under the banner of fat reduction, such as the use of ingredients to mimic texture properties and novel emulsion systems (e.g. water-oil-water emulsions).

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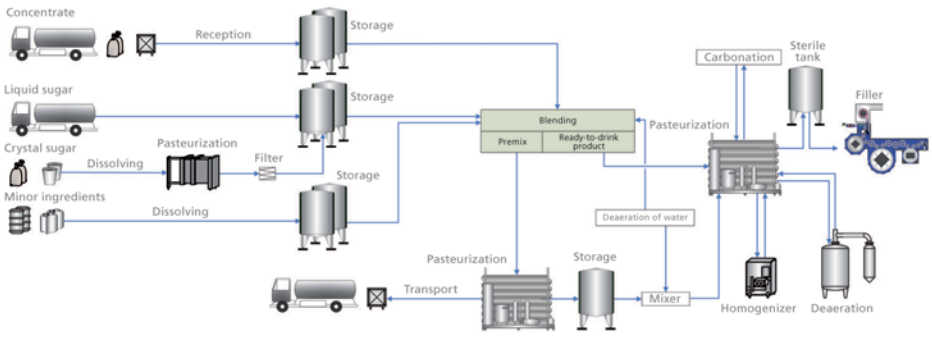
Concept map for continuous blending



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While the replacement of hard fats with polyunsaturated oils has seen significant success in some food groups, there are some sectors where this has been less effective, such as bakery products, fillings and toppings, and reformed meats – in all of which the fat has a significant technological function.

The baking industry has tried switching from using hard fats to baking with healthier alternatives; but this is not easy and brings with it its own set of challenges. In traditional baked treats such as cakes, fat in the form of butter or margarine has a very important structural function, conferring a soft, tender eating quality by helping bubble growth and aeration during baking. The fat stabilises air bubbles in the batter to give a fine crumb structure, creating the soft, springy, sometimes "fluffy" texture which is so appreciated by consumers. Without these interactions, cakes will not rise correctly and mouthfeel and flavour will suffer.

Switching to oils is not straightforward. While oils help to provide a favourable taste, texture and quality, they have a tendency to move around, unlike hard fats, which tend to stay where they are. The result is that oils can often sink to the bottom of cakes after baking, creating an undesirable oily texture. The cake crumb will have a dry eating quality, adversely affecting shelf life.

Nevertheless, hard fats in cakes are being directly replaced by vegetable oils, but the consequence can be that cake quality is often being compromised in terms of cake volume, softness, tenderness, overall appearance and shelf life.

Sugar

Manufacturers have been looking at ways of reducing sugar levels in a variety of formulated products for some time. However, sugar often has a functional role in the product, not just a sweetening role.

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Recent approaches to reducing the calorific value of high-sugar food and drink products have resulted in manufacturers replacing sugars with a range of substitutes including natural sweeteners, blends of sugars, high-potency sweeteners, sugar alcohols and bulking agents with lower calorie contents than sugar. These sugar alternatives have a broad range of characteristics but may not provide any of the technical functions of sugar, and vice versa.

A wide variety of alternative products is available to substitute for sugar in processed foods and beverages and there are some new, intense and bulk low- and no-calorie sweeteners that manufacturers can use.

Modulators

Sweet taste modulators, or enhancers, are designed to target sweet taste receptors in the mouth and "enhance" the taste of sweeteners or sugar, so allowing a lower concentration to be used. In particular, it is hoped that sweet taste modulators will reduce the undesirable aftertaste associated with some sweeteners.

Pulsed delivery

It has been demonstrated that when high-concentration tastant pulses (e.g. salt or sugar) are alternated with low-concentration or water intervals, taste intensity ratings are higher compared with continuous stimulation of tastants at the same average concentration level. Based on this concept it can be expected that if sugar is distributed non-homogeneously (alternated) within a product, taste intensity will be increased, thus resulting in increased acceptability of a reduced sugar food. However, it has also been observed that large concentration gradients between the layers are required to achieve significant sweetness enhancement, and that the gradient diminishes very rapidly – as components like salt and sugar will tend to diffuse through the product.

This clearly presents an issue for food manufacturers, as the concentration gradients required to enhance sweetness perception significantly will not be retained across product shelf life. Manufacturing issues may also be experienced in layers containing no/low sugar due to the fact that, in addition to sweetness, sugar offers functional properties, such as lowering of water activity, bulking and contributions to mouthfeel. Further research is clearly required to determine whether pulsed delivery can realistically be used by the food industry to achieve significant sugar reductions.

Texture and aroma

Food perception is reported to be influenced by a combination of taste, texture and aroma

sensations. It may be possible to enhance sweetness perception using aroma compounds. Increased viscosity has also been shown to decrease sweetness perception; therefore texture modifications should be considered when reducing sugar content.

When food is subjected to mechanical pressure, such as chewing, serum is released from the food matrix. This serum contains tastants, such as sugar. It has been proposed that the food matrix can be altered, in order to increase serum release and enhance the delivery of tastants to taste buds.

Salt

Salt reduction challenges include compensating for its functions such as flavour and microbiological control. The many options for reducing salt include direct or partial replacers, flavour enhancers, and finding different ways of "presenting" salt particles (hollow salt balls, fine or flaked salt) so that lower levels have the same flavour effect.

Food manufacturers are being encouraged to produce products with lower salt contents. However, salt is an important ingredient for the preservation of a variety of products; therefore, manufacturers need to address this issue before reducing salt to ensure the safety of food products.

As with sugar, novel delivery mechanisms are among the avenues that are being investigated to reduce the total content of salt in products, while still retaining product quality.

In recent years there has been progress in reducing salt levels in meat and poultry products. Salt reduction has resulted in adverse changes in flavour, texture, processing and shelf life. However, the negative outcomes can be partially overcome by using salt replacers and mixtures, changing the physical form, adding flavour enhancers and thickeners, and processing with novel technologies.

In conclusion

The above examples demonstrate the complexity of reformulating foods to reduce fat, sugar and salt.

On top of this, manufacturers and product developers also have to take into account the consumer's desire for products with an increased shelf life, whilst retaining or enhancing the "naturalness" or "freshness" of the product. We, the public, are a hard taskmaster!

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Risks in low water activity foods

By Markus Bernasconi, Sales Engineer and Product Manager, Novasina AG

Markus has worked in R&D, product management and sales. *He is a sales engineer/key account manager, responsible for Novasina's water activity instrument portfolio.*

There has long been a belief that food with water activity below 0.6a_w is safe, can be easily processed and comes with a long shelf life. However, recent studies have shown this assumption to be incorrect. Moreover, most companies are missing optimisation opportunities in the manufacturing process and are producing at higher cost than necessary. To understand the possibilities that exist, one must understand the risks and behaviour of components and processes that are applied to manufacture the product.

A false sense of security is dangerous and definitely not beneficial for food manufacturers but it happens daily in food manufacturing plants that produce low water activity foods. As there is a sharp water activity limit for microbiological growth of 0.60a_w, most users expect not to have problems below this value. But what about spores or germs which are still in the product but remain inactive?

What about other sensory changing processes such as oxidation or ingredient degradation? Let's have a closer look to those issues.

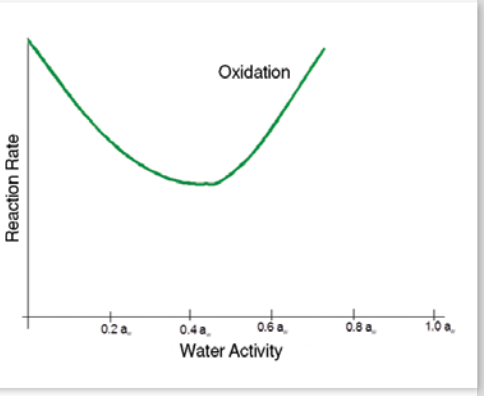
Residual pathogens in the product

Drying or heating in general are used to preserve a product and extend its shelf life, but keep in mind that pathogens cannot be eliminated completely by drying. Spores and vegetative cells can survive in low water activity environments for months even if they do not grow as a_w conditions are not met. Studies have shown that *E.coli*, *Salmonella* and *Listeria monocytogenes* populations survive in environments with a_w of 0.3–0.4a_w. Just believing that below 0.6a_w everything is safe is careless. Additionally, once a dry product is mixed with water on the consumer's side, or by an intermediate, to produce the final product, growth conditions are suddenly present and evolution of dangerous pathogens takes its course.

Secondarily, dry products are mostly hygroscopic. If the storage box or package has been opened and content has been exposed to environmental conditions, humidity from the air is absorbed and changes the a_w value in the product remarkably. This can happen within seconds and, surprisingly, one can find perfect growth conditions for pathogens which no one has expected.

Oxidation and browning

There are a few chemical and physical processes taking place at low water activity levels that need to be understood while manufacturing low water activity food.



"Oxidation is one of the major causes of food spoilage and is initiated by metal ions"

Oxidation is one of the major causes of food spoilage and is initiated by metal ions. The reaction rate falls with a lower a_w value and increases again. The minimum is at 0.3a_w. Free water acts here not as reactant, it is the solvent for metal ions and the

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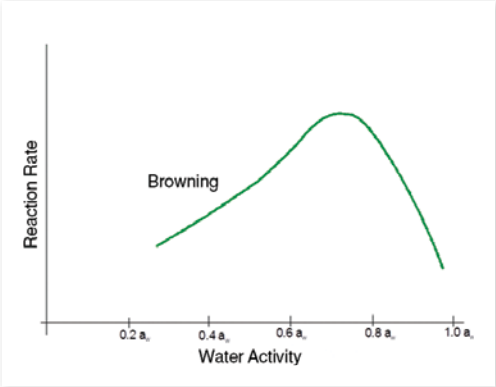
oxygen from outside. Once both are transported to the area of action, where the oxidisable ingredient is present, a reaction takes place. How can this be solved? The first step is bringing the a_w into the area where reaction rate is low. The second opportunity is adding an easily oxidisable ingredient or an oxygen absorber bag. Third, an optimisation of the packaging (sealing and material which do not allow oxygen to pass through) can provide good protection.



In some processes non-enzymatic reaction such as protein denaturation or browning is an enemy for producing safe, high-quality, low water activity foods. As in oxidation processes, free water acts as a solvent to transport the reactants to the place of action. High-risk ingredients are carbohydrates plus proteins as they react and form a brownish product if enough energy (heat) is available the Maillard reaction.

How is a low water activity product created? By drying, which means heat. See the problem? Every milk powder or dried beef producer knows what this is about. The problem with the non-enzymatic reaction is that it changes the product in two ways:

- Optical: discoloration occurs
- Sensory-wise: some products have a bitter taste.

Careful adjustment of water activity levels in the product minimises the risk of inter-product reactions. An additional advantage of conducting a_w measurement is that the drying process can be optimised in terms of temperature, air flow and speed (inlet pressure etc.), which is beneficial for production costs.

Physical properties

As water activity is frequently used for microbial risk assessment, it is sometimes forgotten that free water influences the physical properties of a product. The following points must be considered:

- Two ingredients may have the same moisture content, but totally different a_w values.
- Free water migrates from regions of high a_w to regions of low a_w, and not between areas of unequal moisture content!
- Free water migrates between different layers of a multi-component food, causing undesirable textural changes.

The migration rate depends on structure/diffusion properties.

Now, let's combine this information with low water activity foods. They will be dried by various means (sun-, roller-, drum-, or spray-drying). The basic principle of using heat to evaporate and then remove the water in the product is the same for all. Ever wondered why spray-dried milk powder has to be removed by jackhammer from the tank even if "completely" dried?

The reason for caking and clumping lies in unfavourable drying conditions. If a liquid is dried, small-particle accumulations are created. If drying happens too fast, free water molecules will be enclosed in these aggregations. Even if water draws into the first layers, it sticks there as the outer layer of the particles is hard and dense due to the drying process. If water activity is measured after drying, everything looks fine as the enclosed free water is not immediately detectable. The dried product is transferred into a tank and the nightmare starts. Free water migrates slowly from high water activity areas to low ones, forming bigger accumulations as the products dissolve and re-precipitate.

Finally, there is one big clump that cannot be used. Adjusting drying conditions of product properties and a thorough monitoring of water activity, paired with long-time studies of a_w vs time, will help to control this issue.

In summary

Global competition and higher costs of raw materials and labour are all points on the food manufacturer's agenda. Negotiation for better prices and more automation in the plant is the result, but what about optimising the production process in a reliable and safe way, with less waste? Experience has shown that it is not easy to find good ideas and, if found, there is no clue about the measurement technology or the interpretation of the results. Especially in low water activity/low water foods, food manufacturing becomes critical and the pressure to be economical leads to incorrect process parameters. Water activity is not the Holy Grail solution but it is an important piece in the product quality jigsaw. It offers tremendous potential. Understanding water activity or water behaviour in general in a product helps to make it more stable and extend shelf life.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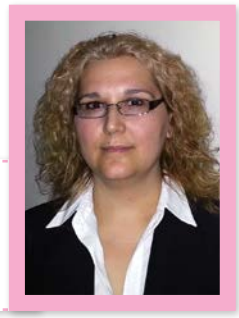
Low water activity foods as pathogen carriers

By Dr Evangelia Komitopoulou, Global Technical Manager – Food, SGS



Evangelia is an expert food microbiologist with specific experience in microbiological risk assessment and specifications, food processing and preservation. *She is also the author of many technical reports and articles.*

Low water activity foods (a_w <0.85) such as cereals, dried fermented sausages, a number of dried powdered foods, grains, seeds, chocolate and others have generally been considered to be shelf-stable with respect to microbial growth. The drop in water activity can be a result of drying (e.g. spray-drying of liquids such as milk) or addition of solutes (e.g. salt or sugars). The minimum water activity for microbial growth is *ca.* 0.60; however, for most bacteria, it is *ca* 0.87. Halophilic bacteria are able to grow at water activity of *ca.* 0.75, while some xerophilic spoilage moulds and yeasts are able to grow at water activities of as low as *ca.* 0.60–0.70.

Low numbers of microbial food contaminants were not, until recently, considered to pose any major safety issue

in low-a_w products in which microbial growth does not occur. However, low-a_w foods as well as dry food processing environments favour the survival of contaminating microorganisms, including pathogens, for prolonged periods of time (microbial survival/persistence can last for years). Depending on the end usage (but also the target population), consumption of a low-a_w food product that contains low numbers of pathogens could result in food-borne illness and therefore their presence in such environments is considered to pose a significant safety risk.

Lack of or insufficient inactivation during processing, as well as post-process contamination, are the main hazards associated with low-a_w foods. The inactivation efficacy of standard heat treatments, such as pasteurisation or high hydrostatic pressure that would normally work with high-a_w foods, is shown to be significantly impaired in low-a_w foods as a result of the significantly higher heat resistance that microorganisms develop in those environments. In most cases, it would be impossible to achieve the same microbial lethality between the two environments (high- and low-a_w foods) without impairing their organoleptic properties. Reported heat resistance data for some *Salmonella* serotypes in low-a_w foods indicate that their heat resistance approaches that of bacterial spores in aqueous systems: heating low-a_w wheat flour at 75 to 77˚C for 2,5 min and pecan nutmeats (a_w 0.52) at 120˚C for 20 minutes reduces *Salmonella* by only about 1 log cfu/g; heating peanut butter at 90˚C for 50 minutes results in a *Salmonella* reduction of 3.2 log cfu/g.

Main pathogens of concern in low-a_w foods include the gram-negative *Cronobacter sakazakii*, *E. coli* O157:H7 and *Salmonella*; gram-positive spore formers (*Clostridium botulinum* and *Clostridium perfringens*); and toxin-producing *B. cereus*. Certain moulds are also able to grow in low-moisture/low-a_w environments and produce mycotoxins (e.g. aflatoxins, ochratoxin). Mould-contaminated foods are considered to be a significant public health concern and, as such, strict limits of mycotoxins in foods are applied.

Several outbreaks of salmonellosis have been associated with the consumption of contaminated chocolate usually present in very low numbers in the incriminated products and being detected many months after the outbreaks. *E. coli* O157:H7 has been reported to survive in infant rice cereal (a_w 0.35 to 0.73) at 5˚ and 25˚C for 16 and 22 weeks respectively, and numerous published reports describe the survival of verotoxin-producing *E. coli* (VTEC) in a number of different products with a water activity as low as a_w 0.21 to 0.38. Survival of even a few cells of e.g. *Salmonella*, *E. coli* O157:H7 (or other serotypes of VTEC), or *Cronobacter sakazakii* have been sufficient to cause disease, particularly in foods containing high levels of protein and/or fat, e.g. dried fermented sausages, chocolate, Cheddar cheese seasoning and various milk-based powders.

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Even though staphylococcal intoxications are of relatively minor importance compared to cases linked to *Salmonella* or VTEC, they are equally relevant to dried foods. Semi-dry products (e.g. cured hams, salami, etc.), foods characterised by slow fermentation or drying (e.g. slow cheese fermentations, pasta drying etc), or those not containing starter cultures (thus relying on "natural fermentation") are at risk of staphylococcal growth and toxin production.

C. perfringens spores are able to survive in dust and on different surfaces and are shown to be resistant to routine cooking temperatures. Spores of *C. perfringens* have been found in powdered infant formula and dried herbs and spices, including black pepper. If these are added to cooked meat dishes, they may give rise to an infective dose if the food is temperature-abused during cooling or storage. *Clostridium botulinum, Clostridium perfringens* and some rare strains of *Clostridium butyricum* and *Clostridium baratii* are able to survive in low water activity foods. Intestinal toxaemia botulism in adults was previously linked to the consumption of peanut butter while, in infants, honey (a_w 0.60) consumption may give rise to infant botulism.

Finally, *B. cereus* spores are able to survive in dry foods such as rice and in dry food processing environments for long periods of time; they can then germinate and grow when products are reconstituted but are improperly processed or stored.

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The effective control of pathogens in low-a_w foods and dry environments should involve the application of the appropriate processing conditions, as applicable, e.g. in drying of liquid foods, as well as the appropriate measures taken to prevent contamination of dry foods and ingredients.

Practical experience has shown that the latter is often a greater challenge to achieve compared to the design of the appropriate control measures for high-a_w foods. The most efficient approaches to preventing contamination are based on the HACCP principles, including the implementation of efficient cleaning and sanitation procedures as well as the appropriate hygienic design and zoning in the food processing environment.

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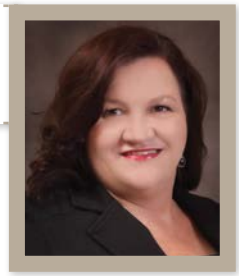
Effective cleaning systems

By Deléne Koekemoer, Director, PHT-SA



Deléne joined PHT-SA (a subsidiary of PHT, Partner for Hygiene and Technology in Germany) in 2008 as Director and COO.

Demands to manufacture food and beverage products under increasingly stringent hygiene regulations mean efficient cleaning solutions are more important than ever.

Effective cleaning and sanitation prevents contamination of food products, averts food-borne illness and minimises food spoilage and, as such, is an integral part of good manufacturing practices (GMP). Proper cleaning and sanitation practices are the foundation upon which food safety assurance systems are built.

Foam cleaning

Any surface that comes into contact with the product (such as tables, knives, cutting boards and conveyor systems) should be cleaned. Indirect areas such as aprons, floors and drains etc. should also not be forgotten. The primary objective of the cleaning process is to remove dirt and product residue, thereby reducing the risk of pest infestation, bacterial growth and biofilm formation.

Bacteria are naturally present in the environment and can survive in fluids and aerosols caused by mechanical action during processing, and cleaning operations such as scrubbing or washing with high pressure. They shelter and proliferate in corners, crevices, cracks, drains, poorly designed equipment, badly drained floor areas and hard-to-reach places. Low-pressure foam cleaning systems are designed for easy and efficient cleaning, sanitising and disinfecting. Foam cleaning's biggest advantage is the prevention of aerosol pollution. Also, compared to high-pressure cleaning that is highly corrosive, it is much gentler and prevents equipment damage.

Low-pressure foam cleaning is used in a variety of environments such as slaughterhouses, abattoirs, fish processing plants, dairies, breweries, butcheries and catering kitchens. A typical installation consists of a booster(s), which provides pressurised water to a number of satellites. Systematic cleaning is done is four phases, namely pre-rinsing; rinsing; foam cleaning; and sanitising or disinfection.

The system can either be centralised or decentralised and consists of:

- a main station or booster pump
- a satellite station
- hose reels and hose
- spraying guns and nozzles
- chemical canister holders.

Significant cost savings

New developments in foam cleaning allow for time saving of up to 40% with the use of up to three different chemicals that can be handled with one single block, through one outlet. The savings not only translate into increased production hours, but also significant labour savings, which account for about 80% of cleaning costs.

The significantly reduced time is achieved by using wet foam before the pre-rinse and by using more water per minute for the pre-rinse.

Lower consumption

Energy and water are saved with this cleaning concept. Due to the large time saving on cleaning, several hours are released for daily production. Using up to three different chemicals raises efficiency to a higher level.

The most important weapon in limiting the risk of bacterial contamination and biofilm is to have a good cleaning procedure in place. Workers should be well-informed about potential contamination and know how to reduce the risk of contamination. Every worker should have a sense of responsibility for the hygiene and food safety in the processing area. However, no hygiene and food safety system can be successful without management's commitment.

Contact Deléne Koekemoer for foam solutions from Foamico at 012 654 3138; dkoekemoer@pht-sa.co.za; www.pht-sa.co.za

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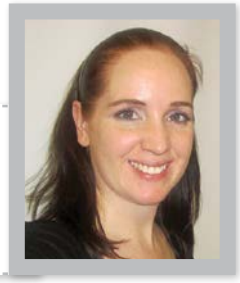
Photo credit: testo/Germany

Monitoring the cold chain wirelessly

By Natalie Liddle, Marketing Account and PR Manager at unitemp



Food production and storage environments require temperature monitoring for reasons that include waste prevention, food safety and regulation compliance. *This article aims to provide guidance on the features to consider when purchasing a wireless monitoring system, and the consequent benefits on offer.*

Evaluating quality and freshness

The uninterrupted monitoring and documentation of ambient conditions and food product temperatures is prescribed by HACCP/ISO 22000 regulations. It is imperative that the system used can produce data files for any time segment, on demand, as proof to auditors of uninterrupted monitoring. In particular, the system must comply with EN 12830 and EN 13485 standards. In the course of a comprehensive certification process, assessors test the system thoroughly and will certify the HACCP conformity of all components. One should, therefore, opt for a system that carries this certification.

Instant notification

Possibly the most important features in an automated temperature monitoring system are alarm and documenting capabilities. Out of control temperatures generate immediate alarms, 24/7, so corrective action can be taken quickly to avoid product loss. Some systems even alert you via e-mail or text messaging.

Hassle-free

Another key benefit of a wireless system is automated documentation. Reports are generated for monitoring and trending analysis. This aids in validation and audits with non-alterable data files and electronic signatures.

Change management

Change management is always a point of concern. Environmental conditions and control points can vary as buildings may expand, departments may move and warehouse areas may be reconfigured. While these changes can be complicated to monitor, they can be made easier to manage when a flexible monitoring system is in place. Most wireless systems can be quickly adjusted and/or reconfigured via software to accommodate changes to a physical space, but a good wireless system should remain flexible if converters/routers need to be added. Certain wireless systems can automate the monitoring of ambient and product temperatures during production and storage, as well as defined temperature limit values during transport. Installing wireless probes in delivery vehicles renders the complicated wiring of a driver's cabin redundant.

Data availability and handling

When data is saved in an electronic format, it's always available. Evaluation and collaboration is much easier when one can access the data at any time. It is important to be able to identify and analyse trends via data graphing. Being able to compare relative temperatures, review HVAC modified cause and effect settings, and identify reduced air circulation, for example, are all essential considerations for indoor environment monitoring.

Reduced response times

Most wireless systems can send out alarm notifications based on the user's specific requirements and needs. An alarm delay can be useful in certain instances, such as a door being momentarily left open during loading or during fridge/freezer defrost cycles. There are also conditions where a notification should be sent immediately – for example, if a probe monitoring a critical area is damaged or loses power.

Be proactive

Having accurate, timely and actionable data on hand allows you to work proactively. Knowing that a problem has just occurred allows for a quick and appropriate response. Timely delivery of information allows trending, predicting environmental control drifting, and even preventive maintenance.

Practically speaking

Some practical applications in South African companies are highlighted below:

- Food storage/transport/logistics
  A significant player in multi-temperature distribution (with distribution centres (DCs) in South Africa) provides key service delivery options to customers within the quick-service restaurant industry. DC staff can access cold chain information, around the clock.

  They decided to use a wireless system because they wanted:
  - centralised temperature monitoring
  - all values reported directly to the central server at their headquarters
  - the system to run on terminal services so that everyone could access information on each DC.

  More recently, the wireless monitoring system has been used in a mobile application. The DC's trucks are fitted with loggers. The driver's cabin is fitted with a wireless display and alarm function to alert him when temperature values are exceeded. Upon return to the DC's base station, the values are automatically downloaded and visible.

- Food production
  Abattoirs need to ensure certain temperature ranges are met throughout various stages of the production process. For example, chicken needs to be cooled down to 2˚C via a water/air chilling process before de-feathering.

  Blast freezers freeze meat products at specific temperatures before going to storage and dispatch. The meat storage area needs to be carefully monitored.

  In addition, many large food producers have their own labs where the ambient temperatures, incubators and fridges (where samples are stored) are monitored.

  With so many different monitoring areas, it becomes a logistical nightmare to record temperatures manually throughout the plant. Wireless helps to simplify this task.

Considerations

Although software ought to be intuitive, training is necessary. Technical support should be readily available. Consultation and advice from a system expert is necessary.

Conclusion

Wireless systems can offer lower installation costs, a greater number of areas that can be monitored and increased mobility. Source a supplier who can recommend and supply the correct monitoring system for your application, but who also offers a comprehensive service.

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Canning: food for the future

By Susan Featherstone, Technical Manager: Food and Beverage, Nampak R&D

Susan presented a paper at the 4th European Meeting of the Institute for Thermal Processing Specialists in Budapest in October 2013.

In September 2012 the UK's Royal Society, the National Academy of Science, named the tinplated food can as one of the three most significant inventions in the history of food and drink (after the refrigerator and pasteurised milk) because of the way it has allowed us to make nutritious foods readily available and easily transportable, all year round.

Canned food has been a star performer from the time that Nicolas Appert first shared his invention in 1810. The number of metal cans of food and beverage manufactured and consumed globally in 2013 is in the region of 302 billion: 241 billion for beverage and 61 billion for food (Euromonitor, 2014). Although there has been much talk of the demise of cans, numbers have grown each year and canned foods are irreplaceable for many reasons.

Contemporary success

There are many reasons for the success of canned foods:

- They are efficiently filled and processed at high speeds
- Tinplate and aluminium provide a perfect gas and light barrier, protecting nutrients
- There is an excellent food safety record (there are very few incidents over the past few decades of food poisoning due to failure of the can: incidents that have occurred involved human error, underprocessing or poor storage conditions resulting in damage and leakage)
- They have a long shelf life (usually at least two years)
- Used cans are the most recycled food and beverage packaging type
- Once canned, products can be stored at room temperature for many years and thus save energy
- Food used for canning is canned when fresh and wholesome, hence the nutritional value of the food and beverages in cans is very good
- Cans are economically efficient. They are 100% recyclable, lightweight and require no energy input during storage.

Trends

Consumer trends indicate a shift towards convenience food. Changing habits in food culture mean varied tastes, increasing demand for ethnic foods and greater willingness for consumers to try new and different foods. Convenience is critical, as consumer demand focuses on processed, ready-to-eat, packaged goods. Health, nutrition and weight control are also important drivers of consumer choices. Finally, sustainability and the impact on the environment are increasingly important to consumers when selecting food.

Consumer education

While canned food can meet all these criteria, consumers need to be educated. Recent studies have shown that the nutritional content of canned food is very good[1]. In 2013 a consumer survey commissioned by the Canned Food Alliance in the USA[2] that asked questions about the perceived benefits of canned foods (including convenience, value and ease of preparation) found that although 80% of respondents said they used canned foods to prepare meals at least twice a month (and 61% of those at least once or twice each week), there was a general misconception about the nutritional content of canned food. While consumers considered canned food to be convenient, generally it was not understood that it offered comparable nutrition to other types of food such as frozen, chilled or fresh.

There are a number of canned food facts that should be better communicated:

- Canned foods are filled with important nutrients (these include protein, fibre, vitamins and minerals essential for a healthy diet)

"Every part can be recycled over and over"


126 Nelson Mandela Bridges...
the equivalent weight of metal we saved last year through our reduced-weight cans.
...just a little bit of Nampak's eco logical thinking.
ecological2
NampakLimited
Nampak DivFood packaging excellence
Nampak Bevcan packaging excellence

- They offer similar nutrition to fresh and frozen foods, sometimes even offering higher levels of important nutrients
- They are minimally processed. Fruits and vegetables destined for cans are picked at peak ripeness and packed quickly after being harvested. After being cleaned and prepared, they are sealed in steel cans and then quickly "cooked in the can" to lock in nutrients and preserve taste and quality. The heat process is carefully optimised
- Tinplate cans are among the safest types of food packaging available. They are strong, tamper-resistant and feature an airtight seal to help keep food nutritious and safe for many years
- There are no preservatives in canned foods. The heat treatment of the canning process preserves the food and no preservatives are required
- Canned foods are not necessarily high in sodium and, on average, contribute less than 1% of the sodium in consumers' diets.

It is estimated that there are over 1 300 different types of canned foods produced in the world (and many more variants). The type of products that can be canned is almost infinite. There is enormous potential for new product developers to make product for developing markets, as well as to conform to the health trends of low sodium, low sugar and low fat.

Recycling

Food and beverage cans are endlessly recyclable, which means that every part can be recycled, over and over. Nearly 75% of all aluminium and 80% of all steel ever produced is still in use today (Can Manufacturers Institute[3]). Currently, most of the beverage and food cans in South Africa are made from tinplate. The collection rates for beverage cans are monitored and reported to be 72% for 2011 – which places South Africa high in the world recycling rates.

In conclusion, food producers should continuously strive to make canned foods more interesting, appealing and healthy. As consumers we should do the right thing and make sure our diet is balanced and varied, and that it includes a fair share of canned foods. We can also do our bit for the environment and sustainability by ensuring that we recycle.

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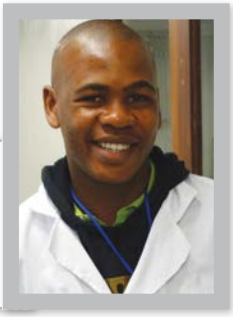
2. Canned Food Alliance telephone survey (landline and mobile numbers) of 1 007 American adults by CARAVAN® Survey. 4–7 April 2013. Margin of error ± 3.1%.
3. **www.cancentral.com/sustainability**

HLPhoto/Bigstock.com

The antioxidant effect of Maillard reaction products in a lipid-rich model system

By Vusi Mshayisa



Vusi is pursuing an MTech at CPUT under the supervision of Professor Jessy van Wyk and Ms Lusani Vhangani. *He graduated cum laude for his National Diploma and BTech and was a recipient of SAAFoST's Aubrey Parsons Study Grant in 2012.*

It is now well established that lipid oxidation is one of the prime causes of quality deterioration in natural and processed foods. Oxidative deterioration is a large economic concern in the food industry since it affects many quality characteristics such as flavour, colour, texture and the nutritive value of foods. In addition, it produces potentially toxic compounds, thus making the lipid- or oil-containing food products unsuitable for consumption (Chaiyasit *et al.*, 2007).

To avoid or delay this autoxidation process, antioxidants have been utilised, with the practice being carried out successfully for over 50 years. The most widely used synthetic antioxidants in food, such as butylated hydroxyanisole (BHA), butylated hydroxytoulene (BHT), propyl gallate (PG) and tertiary butylhydroquinone (TBHQ), have been suspected to cause or promote negative health effects and are perceived negatively by consumers despite being relatively cheap and effective (Osada & Shibamoto, 2006). In addition, these are restricted by legislative rules. Because of this, there is increasing interest in natural antioxidants due to the safety and toxicity problems associated with synthetic antioxidants in lipid- or oil-containing food products. Natural antioxidants have been extracted from fruits, vegetables, spices and herbs. However, some might impart unfavourable sensory characteristics such as flavour and colour to the stabilised food product. Another limitation on these is the necessity to use much higher amounts, often at least tenfold, than synthetic antioxidants (Zhuang & Sun, 2011).

The Maillard reaction (MR) is one area that has received considerable attention due to its promising results. The MR is classified as a non-enzymatic browning reaction, which is a very complex reaction between carbonyl-containing compounds containing sugars such as reducing sugars (aldehydes) or ketones, and a compound containing an amino group such as amino acids, proteins or any nitrogenous compounds. The complexity of this reaction stems from the fact that it is modulated by numerous factors whose unique combination will, each time, lead to a new case study. Parameters influencing the MR include: nature, concentration and proportion of reactants (amino and carbonyl compounds), water activity, heating time and temperature, pH and buffer type and concentration. The MR occurs during food processing and storage and produces a wide range of compounds known as Maillard reaction products (MRPs), which contribute odour, flavour and colour of foods (Osada & Shibamoto, 2006).

yalcin.sonat/Bigstock.com

MRPs from amino acid-sugar combinations have been found to exhibit strong antioxidant activity. Various mechanisms are involved in the antioxidant activity of MRPs including radical chain breaking, scavenging of reactive oxygen species, decomposition of hydrogen peroxide and metal chelation (Vhangani & Van Wyk, 2013).

MRPs as food additives are presumed to be safe since they are

obtained from food which has been used for centuries, while the question of safety of synthetic compounds can be avoided (Rahman, 2007; Gu *et al.*, 2010). The benefits of using natural MRPs include GRAS (generally recognised as safe) status, allowing the use of higher concentrations and worldwide acceptance. Therefore, incorporation of the pre-formed MRPs directly into food systems or application of food processing practices to form MRPs within food can result in improved oxidative stability of foods, and thus they can be considered as substances that are naturally present in foods.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In the present study, the extent of the Maillard reaction was investigated by determining pH reduction and browning intensity while the antioxidant activity of MRPs was investigated by 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging, peroxyl radical scavenging (PRS) and reducing power (RP). The lipid oxidation indices were established in a lipid-rich medium by means of peroxide value (PV) and thiobarbituric acid reactive substances (TBARs). Both lyophilised and aqueous systems were investigated.


zoransimin/Bigstock.com

The change in pH values during the Maillard reaction (MR) was monitored to evaluate its progression. During the MR, the pH of the model system is crucial since the initial condensation step is facilitated by higher pH values. The decrease in pH was found to be consistent with the increase in browning intensity. There was no significant difference ($p > 0.05$) in DPPH-RS of aqueous model systems. There were no significant differences ($p > 0.05$) regardless of increasing temperature and time in the RP and PRS assays in both lyophilised and aqueous systems. Although there were no significant differences ($p > 0.05$) observed between the treatments, the PV exhibited by all MRP model systems was relatively low compared to the specifications set by the Codex Alimentarius Commission. However, no significant differences were observed between TBARs values of MRPs produced at high temperatures, irrespective of the heating time.

The lyophilised MRPs did not exhibit any significant ($p > 0.05$) difference when compared to the aqueous phase, therefore to save time MRPs should be produced and analysed or frozen and stored for later use.

The results of this study proved that MRPs formed during heating possess antioxidant characteristics.

"MRPs formed during heating possess antioxidant characteristics"

In addition, MRPs could be used as antioxidants as well as colour and flavour additives. Hence, the results of this study also confirmed the versatile character of MRPs. Based on the results, further studies are being conducted involving more complex model systems and different time-temperature regimes.

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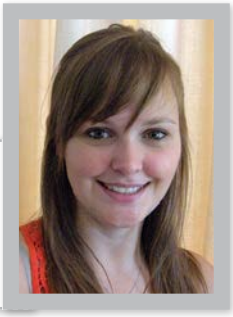
Adding rooibos tea extract to *South African droëwors*

By Maxine Jones



Maxine Jones conducted the research for her MSc degree at Stellenbosch University, Department of Food Science, under the supervision of Professor Louw Hoffman and Ms Nina Muller. *She is currently conducting research for her PhD degree at the same university.*

The development of food products is dependent on consumer preference and needs. The average modern consumer wants a choice of convenient, healthy, value-added products (Resurreccion, 2003). These products tend to include added antioxidants to prolong the shelf life of the product, and to ensure colour stability and flavour improvement (Pokorný, 2001). Consumer awareness of the use of synthetic antioxidants has caused a shift in industry toward the use of natural antioxidants (Markosyan *et al.*, 2009).

Droëwors, a ready-to-eat dried meat sausage commonly made from beef/game meat and animal fat (Burnham *et al.*, 2008), is regularly consumed by South African consumers. It is a high-fat product which is commonly stored for long periods and therefore oxidation is likely to occur. Even though a slight "oxidised fat" flavour is expected by the consumer, adding a natural antioxidant could improve its shelf life.

Another common product regularly consumed by consumers is rooibos tea. Rooibos tea has a high antioxidant profile and a very distinctive flavour. Rooibos tea extract (RBTE) is a concentrated by-product of producing rooibos tea that is commonly added as a food ingredient to various products (Joubert & De Beer, 2011). Limited research has been conducted on using this product as an added antioxidant in meat products (Cullere *et al.*, 2013), although it has been demonstrated to inhibit lipid peroxidation in a number of assays (Joubert *et al.*, 2005; Snijman *et al.*, 2009).

Commercial *droëwors* often contains antioxidants to improve shelf life; therefore, this study set out to use rooibos tea extract as a natural antioxidant in commercial *droëwors* to improve its oxidative stability. Doing this would also hopefully result in an innovative product that would meet the consumer's requirements for traditional South African *droëwors*.

looby/Bigstock.com

Droëwors was produced using game meat and animal fat. The studies included four treatments: a control sample (no added RBTE), 0,25% RBTE, 0,50% RBTE and 1,0% RBTE. Separate batches of RBTE were used in each study. Therefore, it was important to analyse the flavonoid composition of each batch of RBTE as this could affect the results. Chemical analyses included lipid and protein oxidation, haem-iron concentration, fatty acid composition and proximate analysis. A sensory profile was obtained in the follow-up study using a trained panel to describe the product's attributes in terms of flavour, aroma and texture.

An initial study was conducted on three game species, namely blesbok, springbok and fallow deer. These results suggest that the added rooibos tea extract showed no differences between the treatments after drying. But there was a small decrease in lipid oxidation of the *droëwors* samples at concentrations lower than RBTE 1,0%. For the following trial, the *droëwors* formulation was changed slightly, using a different fat source and altering meat to fat ratios.

mybaitshop/Bigstock.com

The following study used blesbok and springbok in the production of *droëwors*. Based on the results of the previous study, chemical analyses and a sensory panel were conducted. A short storage period of two weeks was also included. The results indicate that the RBTE had a positive effect on decreasing lipid oxidation both after drying and storage at increasing concentrations of RBTE.

From this research it was concluded that the *droëwors* formulation and drying parameters are important in the antioxidant action of the RBTE as the results fluctuated with differing formulations. It is also important to analyse the flavonoid concentrations in the extract used as, with different batches, there is wide variation in the flavonoid concentrations and therefore variation in the results.

The final study did, however, show that with increasing RBTE added there was an improvement in the lipid oxidation results. RBTE added a distinctive flavour and aroma to traditional *droëwors*, which were regarded as positive attributes by the trained panel. An informal conclusion can be made that a consumer would respond positively to the added RBTE to game *droëwors* due to the sensory profile that was developed.

This research would be beneficial to the food industry as using natural antioxidants in meat products could delay a rancid flavour by inhibition of lipid oxidation.

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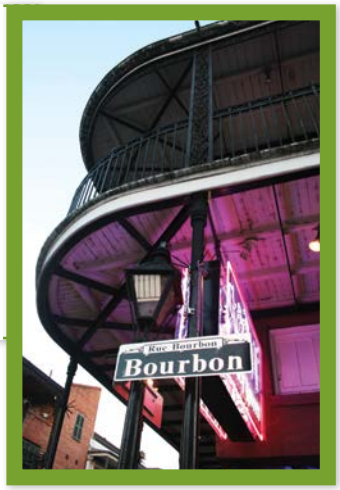
Come and celebrate IFT's 75th anniversary

2014 is an extraordinary year for the Institute of Food Technologists (IFT). The professional scientific society is turning 75 years old and it will celebrate the many achievements of Food Science and Technology and its promise going forward at the IFT Annual Meeting & Food Expo, 21–24 June 2014, in New Orleans. *More than 18 000 Food Science and Technology professionals from around the globe will gather to learn about new Food Science innovations, applications and trends.*



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The event provides attendees with opportunities to discover the latest science and its applications at the Scientific Program; to see, touch, taste and experience the newest ingredients, products and technologies at the IFT Food Expo; and to receive focused, practical education at the Pre-Annual Meeting Short Courses.

The Pre-Annual Meeting Short Courses will be held on 20–21 June. In addition to several recurring courses, IFT will offer new courses that present a wide array of information to help product developers. Some of the new topics include globalised food protection, using consumer research for product claims substantiation, and nutraceuticals and functional foods in sports performance.

The courses are highly interactive and incorporate group exercises, case studies, best practices, practical applications and more in a collaborative, collegial environment.

With nearly 100 sessions and 1 500+ technical presentations slated, the Annual Meeting's Scientific Program is unparalleled in terms of the breadth and depth of content. The Scientific Program offers a variety of tracks, such as Food Safety & Defense, Food, Health & Nutrition, Food Processing & Packaging, Product Development & Ingredient Innovations, Sustainability, Public Policy, Food Laws & Regulations, Food Chemistry, Food Microbiology, Food Engineering, and Sensory Science.

The sessions are clearly identifiable by specific topics and level of expertise, so it's easy for you to build a learning experience tailored to your particular needs.

The Food Expo attracts the largest number of global food industry suppliers in North America. About 900 exhibiting companies at Food Expo will highlight the latest advances in food ingredients, product development, analytical instrumentation, food safety and quality, processing and packaging technologies, and services. Many exhibitors (240+) will sample food and beverage prototypes, which are designed to ensure that attendees enjoy an elaborate menu of formulation inspiration. Specialty & Trend Pavilions on the show floor will include Asia-Pac, Belgium, Beverage – Flavor and Ingredients, Food Safety & Quality, Global New Products/presented by Mintel, Healthy Food Ingredients, Organic Food Ingredients, Special Events Pavilion, and Taste the Trend presented by Innova Market Insights.

The Annual Meeting & Food Expo is also an excellent networking opportunity; those who attend will have a chance to learn about new career opportunities or speak with new talent at the Career Center and take part in festive events like the annual Networking Reception.

"See, touch, taste and experience the newest ingredients, products and technologies"

For more details on the IFT Annual Meeting & Food Expo, please visit www.ift.org/IFT14.

FST Magazine May 2014

Jan Hendrik Hofmeyr

24 August 1934 – 23 October 2013

By Nick Starke

Born and schooled in Cape Town, Jan Hofmeyr (well known in the food and packaging sector) was the first graduate in 1955 from the then-recently-established Department of Food Science at Stellenbosch University.

On graduating, he joined JAX Canning in Grabouw. On joining Metal Box Research (later Nampak R&D) in Maitland, Cape Town, in 1958, he began in the Food Technology laboratory. The purpose was to support Metal Box customers packing food products in metal, paper and plastic-based packaging, developing new recipes and resolving any non-microbiological problems. In this role he interacted with a wide variety of canners and food packers. This also involved working closely with officials from the Department of Agriculture (Product Standards), the Bureau of Standards (SABS) and the Department of Health, Directorate: Food Control. He also had close contact with the Fishing Industry Research Institute (FIRI) in Cape Town and the Food Research Institute of the CSIR in Pretoria.

In time, he became Head of Customer Service at Nampak R&D, and oversaw the Microbiology, Food Technology and Shelf-life Studies Laboratories, and two R&D regional laboratories set up in Johannesburg and Durban. Distant canneries in Walvis Bay, Bulawayo, Botswana, Swaziland and Mozambique were also part of his "parish". Many food factory managers and technical staff came to value his expertise, experience and advice, creating a wide network of contacts. He visited many food food processing plants, locally and overseas, to understand process conditions and share technical advice.

He was a ministerial appointment to the Advisory Committee of the Food Research Institute of the CSIR, and also served on the Technical Committee of the South African Fruit and Vegetable Canners Association. Interested in improving quality, he was part of groups working with the Department of Agriculture on minimum standards for canned fruit and vegetables, and with the SABS in relation to the compulsory regulations for canned fish and meats, under the Standards Act.

Concerned about the training and development of young people, he served on the Advisory Committee of the Cape Technikon for many years, regarding the National Diploma in Food Technology. During the university vacations, he arranged that R&D would host undergraduate Food Science students from Stellenbosch University to gain practical laboratory, factory and packaging exposure.

A loyal member of SAAFoST from its formation in 1961, he always encouraged his staff to become members and take an active part in local Branch meetings and the Biennial Congresses. He himself presented papers and facilitated invitation of invited speakers.

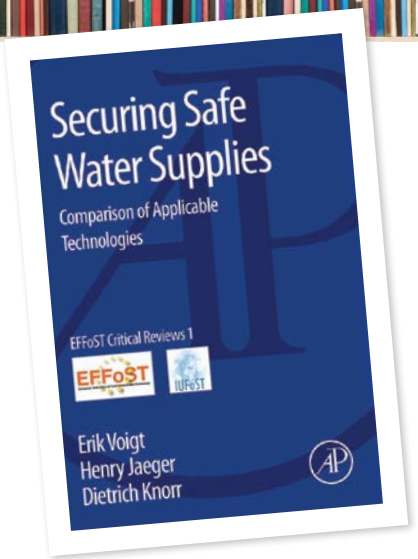
Whomever travelled with Jan in the countryside would know about his passion for birds and have benefited from his deep knowledge of bird identification, behaviours and migrations. This interest led him to become Chairman of the Cape Bird Club and, later, to set up the Tygerberg Bird Club.

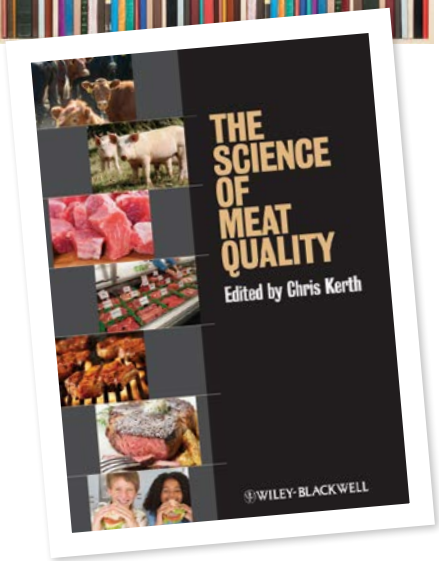
In conversation with Dr Arno Visser and Mr Johan Visser at the official opening of the new building additions at the Food Science department, University of Stellenbosch.

During his long career at Metal Box/ Nampak R&D, Jan made a significant contribution to the maintenance, improvement and safety of packaged foods in South Africa,for local and export markets. Always friendly and helpful, his quiet, unassuming manner, warm personality and shared knowledge will long be recalled with gratitude by his former colleagues and customers alike. He leaves a wife, two daughters and two grandchildren.

"Many people came to value his expertise, experience and advice"

On the bookshelf





Securing Safe Water Supplies

Comparison of Applicable Technologies

By Erik Voigt, Henry Jaeger and Dietrich Knorr

Available water disinfection systems rely mainly on large-scale filtration and the combination of filtration, (to remove solids) and subsequent application of chemical disinfectants. This has proven to produce water of acceptable quality. Important points for application in household systems are low complexity, few training requirements, and easy transportation and distribution as well as a sufficiently high acceptance by the user.

Written and endorsed by the *European Federation of Food Science and Technology*, this book compares a variety of purification systems. There is a growing evidence base on targeting water quality improvements to maximise health benefits, and it is believed that 4% of the global disease burden could be prevented by improving water supply, sanitation and hygiene. Better tools and procedures to improve and protect drinking-water quality at the community and urban level – for example, through Water Safety Plans – include the availability of simple and inexpensive approaches to treat and safely store water at the household level.

E-book and soft cover, 92 pages, Elsevier, 2012.
www.store.elsevier.com

The Science of Meat Quality

Edited by Chris Kerth

Meat has been a long-sought-after source of nutrients in human diets. Its nutrient-dense composition of protein, fats, vitamins and minerals makes it an integral part of healthy and balanced diets. As demand for meat continues to increase globally, a better understanding of efficiently producing quality meat products is becoming increasingly important. The Science of Meat Quality provides comprehensive coverage of meat quality from the biological basis of muscle development to end-product-use topics such as preparation and sensory analysis.

This book explores the basis of meat quality long before it hits supermarket shelves. It opens with a look at cellular muscle tissue development, metabolism and physiology. Subsequent chapters look at topics surrounding the development of tenderness, water-holding capacity, lipid oxidation and colour in meat products. The final chapters discuss producing a good-tasting end product from preparing meat to preventing food-borne illness. Each chapter contains the theory behind that topic and detailed lab methodologies for measuring each meat quality trait.

Hard cover, 293 pages, published by Wiley-Blackwell, 2013.
www.wiley.com

donatas1205/Bigstock.com

May book giveaways

*FST has one copy of **The Science of Meat Quality** to give away. If you would like to enter the draw, please send your name, company details and postal address to editorfst@gmail.com with **FST May book giveaway** in the subject line.*

Congratulations: **Dr Lizel Marais (Prosoy) and Jacques van den Berg (Appletiser) who received copies of our February giveaway books.**

SAAFoST branch news

Northern news

Contact Jannie van Aswegen vanasweg@iafrica.com for news about Northern Branch events

Industry stalwart, Aubrey Parsons, receives the SAAFoST President's Award from SAAFoST Executive Director, Owen Frisby. He is the first individual to be so honoured.

Year-end function

The Northern Branch celebrated the 2013 year end with a five course meal and wine pairing presentation at the School of Tourism and Hospitality in Johannesburg by Glen Carlou Estates.

Steve Kersop (Rich's), Gerald Schell (Carst and Walker) and Jo-Ann Bott (Rich's).

Martin Wiid (Ingreto), Nicole Gilogley (Synergy Ingredients), Julia McCauley and Michelle Miles (Sealed Air).

Professor Vijay Jayasena (School of Public Health, Curtin University in Australia) and SAAFoST Northern Branch Chairman, Jannie van Aswegen.

Owen Frisby (SAAFoST) hands over a Custodian Member certificate to Carst and Walker's Gerald Schell.

University of Pretoria meeting

Afrox Custodian representative Marietha Strydom and Dola Adeboye (Nigerian Institute of Food Science and Technology).

Professors Amanda Minnaar and John Taylor (University of Pretoria).

KwaZulu-Natal news

Contact James McClean james.mclean@hilltopfoods.co.za for event news

Cape news

Contact Dr Gunnar Sigge gos@sun.ac.za for news about Cape Branch events.

Curries of the World cook-off competition

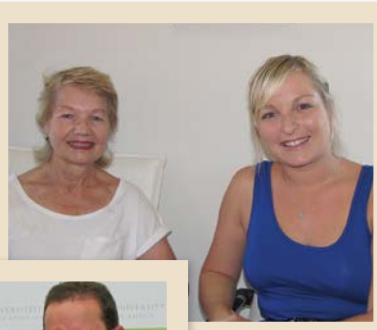
The Cape Branch ended off 2013 with a curry cook-off competition. Bidfood Solutions generously sponsored the venue, ingredients, tea and coffee, while Kerry and Mars Africa sponsored the prizes.

Bidfood's Jennifer du Plessis was instrumental in organising the event.

Nampak's Rudi Muller, Melanie Julius, Morongwa Themba and Susan Featherstone.

Innovation in food and beverage packaging

Daleen du Preez (University of Stellenbosch) and Simone Beling (Marcel's).



Kate Turner (University of Stellenbosch) receives the Jan Hofmeyr book prize (for the student who achieved the highest first-year average) from Dr Gunnar Sigge.

The Mars Africa team: Lisa Ronquest-Ross, Azalea Skelton, Paulina Engelbrecht and Ottilie le Roux.

Athelia Negus, Steve Negus (SABS), Grant Mompléé(Afriplex) and Rolf Uys (AIB International).

Team SAAFoST with two of the Curry cook-off judges: Kareline Masterson (Savannah), judge Hennie Grobbelaar (Bidfood), Jacques van den Berg (Appletiser), Debbie Rabie and Tricia Fitchet (FST) with judge Dr Gunnar Sigge (Cape Branch chair).

Katlego Maseko, Anastashia Diener and Prevashin Gramny (Brandhouse) enjoying the dessert sponsored by Marcel's.

Speaker Morongwa Themba (Nampak R&D).

Events calendar 2014

May 21-22; 27-28 — **Gauteng, South Africa**
FACTS PRACTICAL ALLERGEN MANAGEMENT WORKSHOP
Gain an understanding of how to control allergens in the food manufacturing environment.
www.factssa.com

June 21-24 — **New Orleans, USA**
IFT ANNUAL MEETING & FOOD EXPO
Where the latest global food trends and the products designed to meet them are on display.
www.am-fe.ift.org

June 22-24 — **Midrand, South Africa**
AFRICA'S BIG SEVEN
Promoting the retail sector throughout Africa. Includes the Pan Africa Retail Trade Exhibition, FoodTech and DrinkTech.
www.exhibitionsafrica.com/ems/africa-s-big-seven

June 29 – xJuly 1 — **New York City, USA**
SUMMER FANCY FOOD SHOW
Showcasing 180 000 food products, including confectionery, snacks, organic products and coffee.
www.specialityfood.com

August 5-8 — **Pilanesberg, North West Province**
FOOD TECHNOLOGY FOR EXTRUSION PROCESSING
Promoting the benefits of extrusion technology.
www.extruafrica.org.za

August 17-21 — **Montreal, Canada**
IUFoST
World Congress of Food Science and Technology with the theme "Research that Resonates".
www.iufost2014.org

September 1-4 — **Nantes, France**
FOOD MICRO 2014
The latest research and technological innovations in the field of food microbiology.
www.foodmicro2014.org

October 19-21 — **Paris, France**
SIAL
The world's largest food innovation marketplace.
www.sialparis.com

October 27-31 — **Tel Aviv, Israel**
IDF WORLD DAIRY SUMMIT
Summit for the global dairy sector.
www.idfwds2014.com

November 10-12 — **Vienna, Austria**
WORLD MYCOTOXIN FORUM
Conference discussing strategies to reduce mycotoxin contamination of raw materials.
www.bastiaanse-communication.com/wmf/wmf.html

December 2-4 — **Amsterdam, Netherlands**
HEALTH INGREDIENTS EUROPE
An international exhibition of supplements, nutraceuticals and functional food and beverages.
www.foodingredientsglobal.com

Advert Index

progress EXCELLENCE
management system coaching

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Training • On-site Facilitation

Our approach:

Progress Excellence was established in 2005 to assist national and multi-national organisations on their journey towards business excellence. Progress Excellence believes that Integrated Management Systems should make a difference in improving the business. Progress Excellence staff gained their extensive experience while working in industry, implementing systems that work in practice. We believe that some companies are "systems listed" and that others are "systems driven". The latter experience returns on their investment, as to them, it becomes a way of life and not something that is implemented merely for the sake of certification. With regards to training, a practical approach is followed through interactive training modules. Learning is made fun with the aim of changing behaviours and enabling staff to perform the tasks at hand. Auditing is conducted in a professional manner with the objective to add value to the organisation. A holistic view is taken with regards to business improvements.

Food safety & Quality Management system training

- BRC Global Standard for food safety
- HACCP implementation
- ISO22000 implementation
- Internal auditing of management systems
- FSSC22000 implementation
- ISO9001 implementation
- Administrating the food safety and/or quality management system
- CCP training
- Basic Food hygiene training
- Top management sessions
- Good manufacturing practices
- Supplier Quality Assurance
- Process mapping
- ISO-TS22002 - 1
- ISO22000 lead auditing
- Effective corrective actions
- Food safety team training (based on ISO/FSSC22000)

Laboratory courses

- Laboratory methods for non-scientists
- ISO17025 implementation
- ISO17025 auditing
- ISO17025 awareness
- Microbiology for non-microbiologists

Health & Safety & Environmental Management system courses

- ISO14001 implementation
- OHSAS18001 implementation
- Hazard & risk assessments
- Aspects and impacts study

www.progress-excellence.co.za

Comparing apples with apples?

There's no comparison!

Because we are lawyers who are engineers and scientists with 60 years experience, we know how things work!

Specialising in:

- Consumer Protection Law
- Food Law
- Intellectual Property Law
- Patents and Trademarks

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