Wellness Foods Europe

THE MAGAZINE FOR NUTRITIONAL AND FUNCTIONAL FOODS & BEVERAGES

SafeChoices@Jungbunzlauer

CITROMA® – Minus acrylamide for safe and tasty products

Jungbunzlauer

Reprint from
Wellness Foods Europe
issue 3/2009

CITROMA® – Minus acrylamide for safe and tasty products

by Ann-Kathrin Trierweiler, Market Development Manager – Special Salts, Jungbunzlauer Ladenburg GmbH, Germany

It has been more than seven years since Swedish researchers discovered that after heat treatment, certain foods contain significant levels of acrylamide, a substance known until then only as a highly reactive industrial chemical. They also had found a link between acrylamide and cancer in laboratory rats. But consumers are still unaware of the chemical and its potential effect on their health. As consumers we all expect certain qualities from baked, fried or roasted foods like being lightly browned, pleasingly crunchy and temptingly tasty. Mainly responsible for these product qualities is the Maillard reaction. The Maillard reaction is a reaction between sugars and an amino acid called asparagine, which takes place when starchy foods are processed at high temperatures, e.g. during frying, baking or roasting. One result of the reaction is the creation of a nice brown colour and tasty flavour of baked, fried and toasted foods. But this reaction also creates the suspected carcinogen – acrylamide. The acrylamide concentration in cooked foods prepared industrially, in catering, or at home can range from a few parts per billion (ppb, i.e. µg/kg) up to several 1000 ppb.

Since 2002 the food industry has put much effort into the approach to reduce acrylamide contents in processed foods. But recently food manufacturers have again become under pressure to come up with ways to cut levels of acrylamide in these foods, with pressure coming from the governments.

Canada has already added acrylamide to the government's list of toxic substances, the European Union has tabled a proposal to add acrylamide to the list of substances of very high concerns and the US Food and Drug Administration (FDA) is also considering issuing guidelines to control acrylamide formation and reduction of actual acrylamide levels in foods. This all happened in September 2009.

According to the state of technology European authorities regularly publish signal values for the acrylamide content of different foods. Actual signal values are given in table 1.

Jungbunzlauer offers with the introduction of CITROMA® a new patent-pending method to reduce the acrylamide content in various baked, fried, roasted or extruded cereal and potato based products. Jungbunzlauer's CITROMA® is a special mineral salt which offers a new way to reduce the acrylamide formation in heat treated food products up to 90 % without negative effects on taste. CITROMA® is a GMO and allergen free, special granulation of sodium citrate and a registered trademark in Germany, other states pending. The approved food additive is a fine white, odourless powder with a slightly acidic taste. Besides its ability to reduce the acrylamide formation it can also prevent enzymatic browning e. g. in mashed potatoes.

Table 1: Signal values for acrylamide*

Product	Signal values of acrylamide [µ/kg]
Breakfast cereals	80
French fries, prepared	530
Potato chips	1000
Biscuits	260
Biscuits for diabetics	545
Gingerbread	1000
Crisp bread/Cracker	496

Formation of acrylamide > In 2002, Swedish scientists discovered that after heat treatment, certain foods contain significant levels of acrylamide, a substance known until then only as a highly reactive industrial chemical. At this time there was no data concerning the formation mechanism, health risks, analytics etc. available. But toxicological data suggested that acrylamide is carcinogenic and mutagenic. In particular, starchy foods, such as potato and cereal products, which have been deep-fried, roasted or baked at high temperatures showed high levels of acrylamide. By now the formation mechanism is almost completely resolved, analytics for many products established and the risk assessment is still ongoing. Acrylamide is formed by the reaction of reducing sugars with free asparagine (an amino acid) in the context of the Maillard reaction. Low water contents accelerate the reaction. In many cooking processes, the Maillard reaction is the predominant process responsible for the brown colour and tasty flavour of baked, fried and toasted foods. High temperatures above 120°C (248°F) and the heating time are two major factors for the final acrylamide content of the food.

Elimination of acrylamide from foods is virtually impossible – the principal objective must be to reduce the amount formed in a given product. There are different methods available to reduce the acrylamide content in foods, such as the use of amino acids and pH controlling agents or changes in processing temperature, heating time and moisture control.

Current methods of acrylamide reduction > A number of approaches varying from agriconomical aspects to changes in recipes or pro-

cessing to lowering the formation of acrylamide can be readily applied. For example, avoiding over-frying or over-baking of potato products in particular (as indicated by excess browning) can significantly lower the levels of acrylamide formed when compared with products more lightly fried or more lightly baked. Different methods that focus on changes in ingredients are already recommended from food safety agencies. These methods were developed with the food industries e.g. for the use in potato products (chips, snacks, French fries and related products) and cereal product (breakfast cereals, gingerbread, crisp bread, and biscuits) to tackle the problem of acrylamide formation. But most of them face still some disadvantages. Some of the methods are mentioned in table 2:

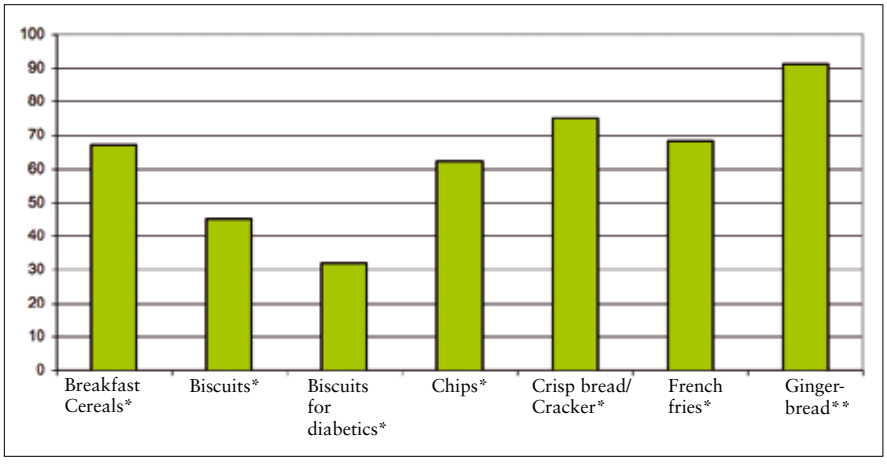
CITROMA® and acrylamide reduction >
The control of detrimental acrylamide in food plays an important role for food manufacturers to address food safety and consumer concerns. With the development of CITROMA®, Jungbunzlauer can offer manufacturers a new solution for a new solution for an easy handling and very effective acrylamide reduction in various food products.

The development of CITROMA® had several targets: Jungbunzlauer purposely pursued the development of a new method, capable of reducing the acrylamide levels significantly without influencing the manufacturing process of the final products: production capacity, costs or any negative influences on the production equipment.

Table 2: Current methods for acrylamide reduction in cereal and potato based foods

Product type	Method	Disadvantage
Potato product	Soaking potatoe slices in glycine or glutamine solutions	Indistinct nutritional impact of glycine
Potato product	Soaking potatoe slices in a solution containing $CaCl_2$	Corrosion of the equipment, typical metallic to bitter off-taste
Potato product	Addition of citric acid and glycine to the recipe	Indistinct nutritional impact of glycine
Potato product	Blanching of French fries	Minor reduction levels
Potato products	Calcium salts	Hard texture and bitter off-taste in finished products, most calcium salts are not compatible with pyrophosphates which are used to prevent enzymatic browning
Cereal products	Enzymatic treatment e.g. with asparaginase	At least 30 min residence time, enzymes can cause allergies; efficacy of the treatment may vary, and will need to be tested on a case-by-case basis
Cereal products	Addition of glycin as dry minor ingredient	Changes of product colour and taste (very dark products, bitter off-taste)
Cereal products	Addition of calcium salts	Most have adverse flavour effects, non have been commercialised for cereal applications

Figure 1: Acrylamide reduction levels of CITROMA® in potato and cereal based foods



*results of lab-scale trials, **results of industrial trials; used CITROMA® concentrations: biscuits and biscuits for diabetics 0.5 %, chips 0.6 %, breakfast cereals and crisp bread 0,75%, gingerbread 0.8 %, French fries 1 %

Based on research from Jungbunzlauer Application Technology Center and external institutes, as well as data from industrial trials of food producers, Jungbunzlauer's CITROMA® demonstrated excellent results reducing acrylamide content in French fries, chips, breakfast cereals, and related products up to 90 % [figure 1] without influencing sensorial properties or the manufacturing process.

Function of CITROMA® in acrylamide reduction > With the use of CITROMA® in specific concentrations the critical part of the Maillard reaction where acrylamide is formed can be inhibited. The mechanism is a synergistic combination of lowering the pH, a chelation effect and presence of a small amount of sodium in the molecule. But even if the Maillard reaction is influenced, the final product still has its original sensorial properties regarding colour, crispiness and taste.

Applications of CITROMA® > Main applications for CITROMA® are cereal and potato based products, like French fries, chips and snack products, breakfast cereal and a wide range of bakery products, with usage levels ranging from 0.2 % to 2.0 %, depending on the application.

CITROMA® can be used in two ways. Either as dry ingredient where it is mixed with the other ingredients of a formulation or in a wet application where the product is dipped in or sprayed with a CITROMA® solution. Recommended concentrations depend on the contact time of CITROMA® with the products. By treat-

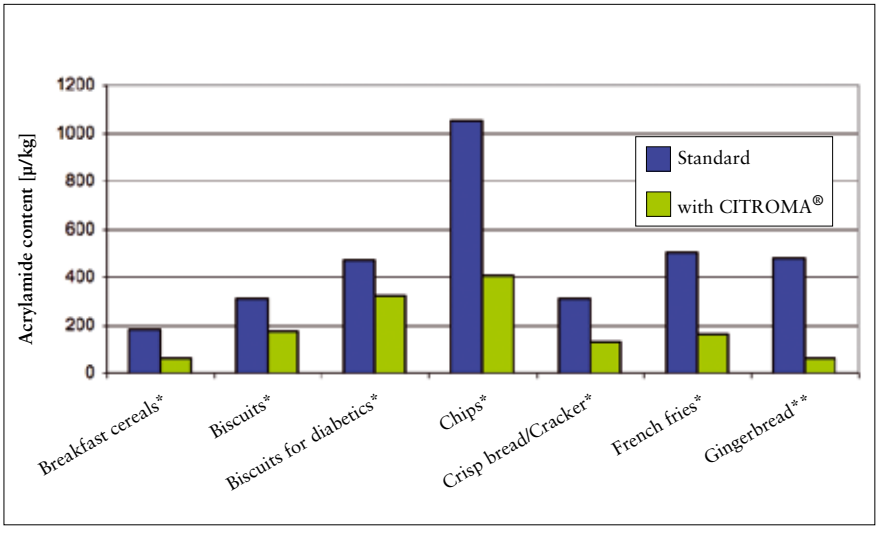
ing the product with CITROMA®, the acrylamide content can be reduced significantly [figure 2]. Due to its superior solubility it is excellent for those applications as it does not lead to any delays in the further processing.

Application in potato products > For the treatment of potato products like French fries or chips CITROMA® can be directly added to the blanching bath, a dipping bath or a spraying solution prior to freezing or further processing.

When the contact is rather short (2–5 seconds) a concentration of approx. 2.0 % in the solution is recommended, whereas at longer contact times (20–60 seconds) concentrations of 0.8–1.3 % have exhibited very good results for acrylamide reduction without showing any difference to the standard product. CITROMA® can also be used in potato based snack products which are made from potato flakes or other potato intermediates. Here CITROMA® is added as a dry ingredient into the dough the products are made of. When used as a dry ingredient, 0.5% CITROMA® based on dry ingredient weight presented best results in lab-scale experiments but also industrial scale trials.

Application in breakfast cereals and bakery products > Typical dry applications are formulations used in breakfast cereals, extruded snack products or bakery products. For the production of breakfast cereals – irrespective of whether the product is made by extrusion or using the traditional cooking process – CITROMA® can be added to the dry ingredient mix just as sugar or salt are added. Best results were experienced at concentrations of 0.5–1.0 % CITROMA® based on the weight

Figure 2: Summary of test results for acrylamide reduction with CITROMA®



*results of lab-scale trials, **results of industrial trials; used CITROMA® concentrations: biscuits and biscuits for diabetics 0.5 %, chips 0.6 %, breakfast cereals and crisp bread 0,75 %, gingerbread 0.8 %, French fries 1 %

of dry ingredients, with an acrylamide reduction of 68 %.

CITROMA® has also been tested in bakery applications such as biscuits, diabetic biscuits, gingerbread and crisp bread. In bakery products CITROMA® is commonly used as a dry ingredient and concentrations used are based on the content of flour. For applications in biscuits, 0.5 % CITROMA® resulted in best acrylamide reduction results without affecting any organoleptic aspect. Reduction was 45 % in common biscuits and 32 % in diabetic products, since products with fructose are even more prone to acrylamide formation. In crisp bread and cracker like products concentrations up to 1 % CITROMA® had no negative impact on colour or taste and resulted in up to 75 % acrylamide reduction. The use of the raising agent ammonium bicarbonate has been found to increase the potential for acrylamide formation due to the ammonium component. The problem with ammonium carbonate is the ammonia that it releases during baking. It reacts with glucose and fructose in the dough to form unusual molecules that in turn react very efficiently with asparagine to form acrylamide.

But in products like gingerbread ammonium bicarbonate can not be replaced by other raising agents easily as ammonium bicarbonate is responsible for the formation of aromatic compounds which are characteristic for these products. With the use of 0.8 % CITROMA® in gingerbread, results of an industrial trial exhibited significant acrylamide reductions up to 90 %. This offers new possibilities to produce gingerbread with low acrylamide content without restrictions in taste.

In some plain bakery products CITROMA® may cause a slightly sour off-taste. To overcome this problem a treatment of the products surface with CITROMA® solution may also be possible.

Benefits of CITROMA® over other acrylamide reduction methods > CITROMA® is easy to incorporate into existing formulations and has several distinctive advantages over other acrylamide reduction methods. The ingredient can be added to formulations by direct addition to a dry mix or dough, or it can be incorporated into a dipping bath or spraying solution. CITROMA® has excellent flowability and dissolution characteristics which offer the possibility of pneumatic fostering and continuous production as there is no residence time needed. The use of CITROMA® is pH- and temperature-independent and thus requires no special processing conditions. Further, it is cost-effective, GMO and allergen free and does not cause corrosion in processing equipment. All advantages of CITROMA® are summarised in figure 3.

Another frequently used technique to reduce acrylamide is the use of specific enzyme systems that block the amino acid asparagine. Table 3 lists the advantages of CITROMA®.

Legal aspects > In the European Union, CITROMA® is listed as a generally permitted food additive (E 331). It may be added to

Figure 3: Advantages of CITROMA®

Advantages of CITROMA®		
Product Quality	**Processing**	**Economics**
Up to 90 % acrylamide reduction	Excellent dissolution	No rentention time necessary
Neutral taste	Suitable for pneumatic transport	Easy handling
Minimal effects on pH levels	Non-corrosive	Low cost of use
No GMO or allergen issues	For wet and dry processing	No labelling
	Heat stable	

all foodstuffs, following the "quantum satis" principle, as long as no special regulation restricts the use. Jungbunzlauer CITROMA® is supplied in accordance with the requirements of the Commission Directive 2008/84/EG. In the USA, CITROMA® is generally recognized as safe (GRAS) within the meaning of the Federal Food, Drug and Cosmetic Act, and may be used in food and beverages in full compliance with the applicable Food and Drug Administration (FDA) regulations.

Declaration > The use of CITROMA® has not to be labelled on the final product packaging when used as a processing aid. Unfortunately CITROMA® is not approved for the use of organic (bio) foods based on plant origin like potato or cereal products but can only be used in organic (bio) products of animal origin.

Conclusion > Jungbunzlauer's CITROMA® belongs to the SafeChoices@Jungbunzlauer product platform and offers a safe and easy way of acrylamide reduction in starchy heat treated foods. It offers manufacturers of several products that are at risk for increased acrylamide contents, an easy and cost effective way to produce high quality, good tasting products without influencing sensorial properties.

Table 3 Benefits of CITROMA® vs. enzymes:

Relevant Aspects	CITROMA®	Enzymes
Acrylamide reduction without negative impact on product quality	YES	YES*
Negative influence on processing equipment (e.g. corrosion)	NO	NO
Easy handling and storage conditions	YES	NO
Allergenic potential	NO	YES
Additional processing equipment necessary	NO	YES
Reduction of production capacity	NO	YES
Residence time necessary in processing	NO	YES
pH value dependent process	NO	YES
Increased in sodium content	YES**	NO
Approved for food applications *(processing aid)*	YES	YES

*following conditions must be obtained: residence time approx. 30 min, opt. temperature range 50–63°C (°F), opt. pH 5.5–7.5
**Increase in sodium content max 0.1 %, can be balanced via reduced NaCl addition in most products

The Author: Ann-Kathrin Trierweiler
Market Development Manager Special Salts
Jungbunzlauer Ladenburg GmbH
Dr.-Albert-Reimann-Str. 18
D-68526 Ladenburg
Germany
Phone: +49 6203-104 0
Fax +49 6203-104 210
E-mail: SafeChoices@Jungbunzlauer.com
www.jungbunzlauer.com