

# CARAMEL & HEALTH

WHAT'S TODAY'S SITUATION?



“ The art and science  
of caramelization ”

*Nigay*  
The expert in caramels

**nutrifizz**  
Nutritional Valuation Consulting



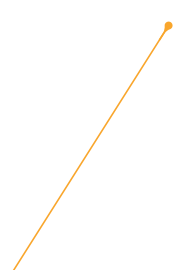
In the consumer's mind, caramel is a product associated with taste, pleasure, childhood...

## **Why is caramel a topic of particular interest?**

The word "caramel" is not limited to confectionery, but refers to various products depending on recipes and applications (food, ingredients for flavouring, additives for colouring).

Caramel is widely used in the food industry. Over time the question of a link between caramel and consumer health has been raised.

*This monograph presents an overview of the current knowledge about caramel, and especially aromatic caramels and caramel colours.*



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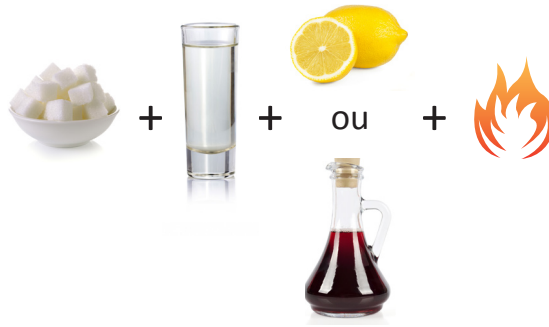


# PART 1

## From confectionery to additives, caramel forms different products

### The caramelisation process

Caramelisation is a traditional cooking method which includes sugar heating treatment, beyond its melting point, in presence of an acid catalyst (lemon juice or vinegar).



The basic recipe is very simple!

Everyone is able to make caramel: sugar + water + lemon juice or vinegar + heating

### A diversity of products

The word "caramel" seems so familiar, but it defines actually plenty of different products. Depending on recipes and applications, caramel will be considered as a **food** (example: candy toffee type), an **ingredient** (aromatic caramels and caramel specialities) or an **additive** (caramel colours).

#### AROMATIC CARMELS



Used as ingredients, they are identical to "home made" caramels by the gourmet in his pan or the pastry chef in his cauldron. Control of the temperatures with high-technology cookers, rigorous quality control, warranty of constant characteristics on the finished products, are the advantages with an industrial process compare to the domestic or craft processes.

#### CARMEL COLOURS



Used as colour additives, these caramels are manufactured using caramelisation promoters (sodium sulfite, ammonia, ammonium sulfite) to obtain a high colouring power and a good stability into the different food products to which they are added. Their safety is demonstrated through toxicological studies validated by the European and international health authorities. There are to date 4 classes of caramel colours (E150a, E150b, E150c and E150d).

#### BURNT SUGARS



Some caramels called "burnt sugars" assimilate both EU definitions of aromatic caramel and caramel colour. These caramels are dark brown and produced from sugars and water only. If it is possible to prove that the caramel brings flavour to the finished products through a blind test, it will be considered as a burnt sugar; in otherwise the caramel will be declared as a colouring agent E150a.

#### CARMEL SPECIALITIES



The caramel specialities are sugar confectionery, into which are incorporated by dairy products (milk powder or concentrates, butter or cream), vegetable fats and sometimes other ingredients such as fruit extracts. The variety of names (hard or soft caramel, "fudge", "toffee") depends on the composition, cooking process, shape of the finished product and its flavour profile.

# PART 2

## Use and consumption of caramels

### Aromatic caramels

Aromatic caramel is now a popular flavour found in many product categories, salty or sweet (custard, puddings, caramel pork, "energizers"...). To date, no study has evaluated the specific level of consumption of aromatic caramels.



### Caramel colours

Caramel colours are widely used in a large range of foodstuffs (non-alcoholic soft drinks, confectionery, soups, seasonings, beer, bakery...). The use levels of caramel colours for several categories of finished products were recently made available to the European Food Safety Authority (EFSA)<sup>1</sup>. This information was used to review the level of intake of caramel colours E150a, E150c and E150d, in Europe.

<sup>1</sup>European Food Safety Authority. 2012. Refined exposure assessment for caramel colours (E 150a, c, d). EFSA J.10:3030.

## KEY-FIGURES: A high level of use of caramel colours and aromatic caramels in the food industry

Caramel colours,  
account for more than

**80%**

(by weight) of all  
colourings added to food  
and drinks.

The annual global  
production of caramel  
colour is estimated at

**several  
hundred  
thousand tons**

For aromatic  
caramels and caramel  
specialities, variety  
of manufacturers and  
applications does not  
permit estimation of  
the production level.



# Focus on non-alcoholic soft drinks

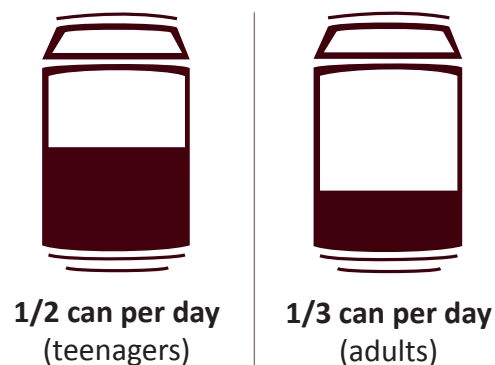
In France, caramel colours E150b, E150c and E150d are present in **15.5%** of non-alcoholic soft drinks, for instance in cola, energy drinks or iced tea (several grams per litre are used for colouring).

As the consumption of soft drinks reached on average **180 litres/inhabitant/year** in the US (the equivalent of 1.5 cans per day) and **94 litres/inhabitant/year** in Europe, since 2003, soda-type beverages are a major source of dietary consumption of caramel colours, especially for large consumers (children and young adults).

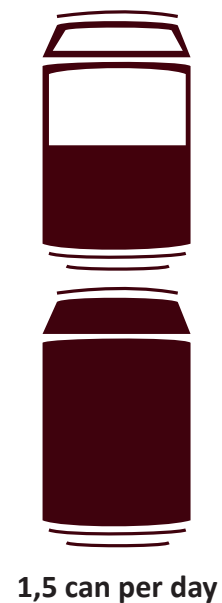
The French population is among the smallest consumers of non-alcoholic soft drinks in Europe: **60.8 litres/inhabitant/year** (the equivalent of 1/2 can per day for a teenager and 1/3 can for an adult)<sup>2</sup>.



<sup>2</sup>Eating behaviour and consumption survey in France (CCAF), CREDOC 2013



 FRANCE



 USA

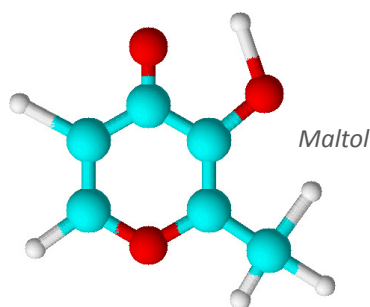
# PART 3

## Composition of caramels ... Discover their richness!

CARAMEL: A MIXTURE OF MOLECULES WITH DIFFERENT PROPERTIES

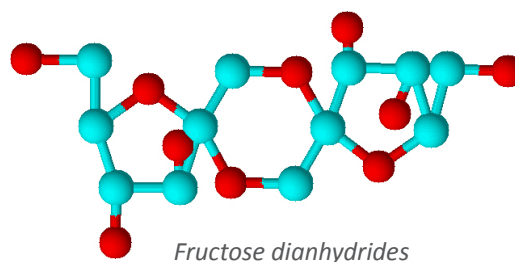
### Volatile fraction<sup>3</sup>

One hundred volatile compounds have been identified (**maltol**, cyclotene, furaneol, furfural...), demonstrating the aromatic richness of caramel<sup>4</sup>. It is the combination of these molecules that creates the typical caramel flavour. They represent 5 to 10% of the composition by weight of caramel.



### Non volatile fraction

Major constituents of the non volatile fraction of caramel (90 to 95% by weight) belong to the family of simple (fructose, glucose, **fructose dianhydrides**...) and complex (oligosaccharides) carbohydrates. They are responsible for the flavour and texture of the caramel as well as for giving rise to a family of brown polymers called melanoidins contributing to the colour of caramel.



<sup>3</sup>Refers to a molecule that evaporates easily, may turn into gas, steam.

<sup>4</sup>Paravisini L et al. (2015). Characterisation of the volatile fraction of aromatic caramel using heart-cutting multidimensional gas chromatography. Food Chem. 2015 Jan 15; 167: 281-9.

## How to calculate the energy value of caramel?

The assessment of energy value may be achieved by nutritional analysis or calculations from the caloric value of proteins, lipids (also called fats) and carbohydrates (in kilocalories/gram).

Lipid = 9 kcal/g

Carbohydrate = 4 kcal/g

Protein = 4 kcal/g

Fibre = 2 kcal/g

The energy value of caramels mainly relies on the composition of the **carbohydrate fraction**, particularly for caramel colours and aromatic caramels.

Contrary to caramel specialities, whose recipe can include other ingredients than carbohydrates (milk, butter, fruit extracts, cocoa, etc.), colouring and aromatic caramels contain no protein or fat.

The energy value of caramels is currently calculated using the conversion factor of **4 kcal/g** but this calculation overstates the result because caramels contain some carbohydrates considered as **dietary fibres**.



# What is dietary fibre?

"**Dietary fibres**" are carbohydrate polymers with three or more monomeric units, which are **neither digested nor absorbed** in the human small intestine and consequently have a lower caloric value (2kcal/g) compared to the carbohydrates.

Dietary fibres present at least one of the following properties:

- Increases production of stools
- Stimulates bacterial fermentation in the colon
- Decreases the amount of fasting blood cholesterol
- Decreases the amount of glucose and/or insulin in blood after a meal

According to Nutrinet-Health study, only **10%** of men and **4%** of women in France consume the optimum recommended threshold of 30 g/day of dietary fibres.

# PART 4

## Caramels and Health: Regulations and potential risks

*Aromatic caramels and caramel specialities are ingredients like flour or sugar. There are no limitations on their uses.*

### ARE THERE RISKS ASSOCIATED WITH CONSUMPTION OF CAMEL COLOURS?

**Regulation (EC) No 1129/2011** establishes a list of all permitted food additives and their conditions of use, including caramel colours.

Food additives may be associated with:

- an **Acceptable Daily Intake** (ADI) (maximum dose of a substance, expressed as mg per kg body weight per day (mg/kg bw/day), to which it is possible to be exposed repeatedly throughout one's lifetime without appreciable risk to health);
- a **maximum use** in foodstuffs (or some of them).

### ACCEPTABLE DAILY INTAKE FOR CAMEL COLOURS

Group ADI of  
**300 mg/kg bw/day**  
(21g/day for a man who would weigh 70 kg) for the exposure to 4 classes of caramel colours E150a, b, c, d.

Specific ADI of  
**100 mg/kg bw/day**  
(7g/day for a man who would weigh 70 kg) for the caramel colour E150C.

The estimated combined exposure to the four caramel colours does not exceed the ADI of 300 mg/kg bw/day for all segments of the population in Europe (Efsa, 2012). The only exception concerns the ADI for E150c which could be exceeded for some population groups with high levels of consumption.

### MAXIMUM USE IN FOOD

The right amount consistent with good manufacturing practice for all caramel colours!




To avoid exceeding the ADI for caramel colour E150c, found in 2012 to be a risk for high consumers of beer in Belgium, Netherlands, Ireland, United Kingdom and Czech Republic, Regulation (EU) No 505/2014 has established a maximum use of E150c in beer and malt beverages.





## HEAT-FORMED COMPOUNDS IN CARAMEL UNDER SPECIFIC SURVEILLANCE IN EUROPE AND USA

Regulations about maximum levels have been established for two heat-formed compounds (in mg/kg of caramel colour for a 0,1<sup>5</sup> colour intensity):

Geographical area	Europe 	USA 	Rest of the world 
Regulation	Regulation (EC) No 231/2012	Food Chemicals Codex <sup>6</sup>	JECFA <sup>7</sup>
4-methylimidazole E150c	200 mg/kg	250 mg/kg	200 mg/kg
4-methylimidazole E150d	250 mg/kg	250 mg/kg <i>Specific regulation in California</i>	250 mg/kg
2-acetyl-4-tetrahydroxybutylimidazole - E150c	10 mg/kg	not defined	25 mg/kg

<sup>5</sup>The more a caramel is coloured, the less is the quantity of caramel added to the finished product. Indeed the concentration of newly formed compounds is established at a standard colouring intensity, calculated by the absorbance in 610 nm of a solution of caramel to 1 g/L.

<sup>6</sup>Sets the pharmacopoeia standards in the US (United States Pharmacopeia).

<sup>7</sup>Sets international standards through an expert committee of the United Nations and the World Health Organization.

In California specifically, the "Proposition 65" sets a lower limit to the level of exposure to 4-MEI. This law requires for beverages manufacturers to put a warning symbol of cancer risk on their labels if the maximum exposure, defined in this state to 29 µg/day/person, is not respected. A decrease of 4-MEI levels, from 250 mg/kg to 10 mg/kg in caramel colours E150d, is essential to meet this level of exposure.

The manufacturers of caramel colours carefully monitor the scientific and regulatory development relating to their products to ensure they comply with current regulations and are completely safe for the consumer.

These heat-formed compounds may also be found in other food products obtained by the thermal treatment of sugars such as coffee, bread, cereals ...

# PART 5

## Caramel and Health: Components of interest and potential benefits

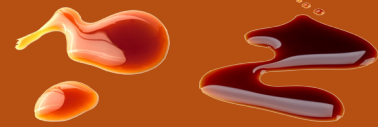
### Fructose dianhydrides

Fructose dianhydrides or DFAs are interesting components naturally present in caramels, in varying amounts, depending on the raw materials and manufacturing processes used.

DFAs are formed by condensation of two molecules of fructose combining, and DFAs may be the major part of aromatic caramels (up to 80% by weight in some caramels).



The more the aromatic caramel presents a high degree of caramelisation, the more the content in DFAs is likely to increase<sup>8</sup>.



Light colour  
DFAs 5%

Dark colour  
DFAs 20%

<sup>8</sup>Defaye J et García Fernández JM. (1995). The oligosaccharides components of caramel. *Zuckerind.*, 8, 700-704.

### Potential benefits of DFAs

In the last 10 years, a number of scientific publications have demonstrated many potential promising properties of DFAs such as<sup>9</sup>:

- Potential prebiotic effect (growth of certain bacteria recognised as "beneficial for the health of the host" such as bifidobacteria or lactobacilli within the gut microbiota)
- Anti-cariogenic effect
- Improvement of the intestinal transit
- Improvement of mineral absorption (calcium, magnesium, iron)
- Stimulation of immunity
- Decrease of the pathogenic bacteria
- Fibre-like health effects

<sup>9</sup>Tamura A et al. (2003). Evidence suggesting that difructose anhydride III is an indigestible and low fermentable sugar during the early stages after ingestion in humans. *J Nutr Sci Vitaminol (Tokyo)*. Dec;49(6):422-7. García-Moreno MI et al. (2008). Chemical and enzymatic approaches to carbohydrate-derived spiroketals: di-D-fructose dianhydrides (DFAs). *Molecules*. Aug 12;13(8):1640-70. Arribas et al. (2010). Di-D-fructose dianhydride-enriched caramels: effect on colon microbiota, inflammation, and tissue damage in trinitrobenzene sulfonic acid-induced colitic rats. *Agric Food Chem*. May 26;58(10):6476-84. Mellet Co, García Fernández JM, Difructose dianhydrides (DFAs) and DFA-enriched products as functional foods, *Top Curr. Chem*. 2010, 294, 49-72

### What is a prebiotic?

Prebiotics are compounds, usually carbohydrates that can help the development of the gut microbiota, including bifidobacteria and lactobacilli, and may contribute to potential health benefits in humans. To fulfill this role, prebiotics require the properties of "non digestibility" and "fermentability".





# Melanoidins: Brown pigments of the caramels

The caramelisation process is one of the reactions called non-enzymatic browning which can result in the production of melanoidins, pigments responsible for the brown colour of different foods (coffee, beer, bread crust, caramel ...).

Since the 2000s, studies have been conducted on many foods and beverages including coffee, beer, vinegar, honey and certain cereal products to better characterise the components of interest and establish a possible link between melanoidins present in food and potential health effects.

## Potential positive health effects identified

A recent review<sup>10</sup> has identified various potentially positive biological activities of melanoidins:

- Antioxydant capacity
- Antihypertensive activity
- Potential prebiotic effect
- Anti-microbial activity, particularly in terms of food preservation
- Inhibition of the growth of tumour cells

<sup>10</sup>Wang HY et al. (2011). *Melanoidins produced by the Maillard reaction: Structure and biological activity*. *Food Chemistry* 128,573–584

According to the results of Nutripan project, some compounds, with similarities to soluble fiber, are formed during bread baking and, may be classified as melanoidins<sup>11</sup>.

<sup>11</sup>Helou Cet al. (2016). *Maillard reaction products in bread: A novel semi-quantitative method for evaluating melanoidins in bread*. *Food Chem.* 2016 Jan 1;190:904-11

## What about caramel's melanoidins?

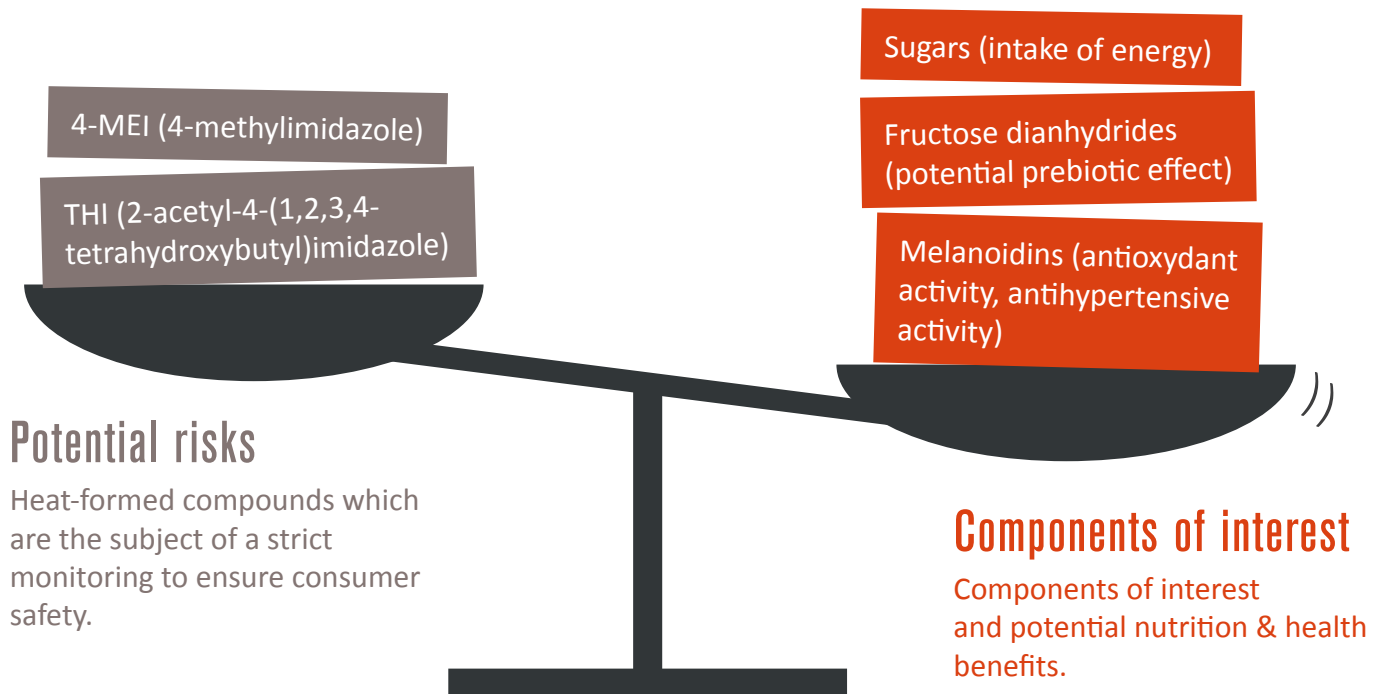
The darkest caramel colours (E150c and E150d) are likely to contain the highest amounts of melanoidins. However, to date no data on the melanoidins of a specific caramel has been the subject of a scientific publication.

**Everything remains to be done!**

# PART 6

## Key points to remember

### COMPONENTS OF INTEREST AND POTENTIAL RISKS IN AROMATIC CARAMELS AND CARAMEL COLOURS



## Key points:

- The word "**caramel**" is used to define several types of products (aromatic caramel, caramel colours, burnt sugars and caramel specialities), respectively used as a **food, ingredient** for flavouring or an **additive** for colouring foods and beverages.
- Caramel is a **mixture of volatile** (5-10%) and **non-volatile** (90-95%) molecules.
- Aromatic caramels and caramel colours are widely used in the food industry to bring **flavour and colour** to foods.
- The caramel colours, as well as all additives used in the food industry, are governed by **specific regulations** to ensure consumer safety.
- Caramel manufacturers ensure that **products are safe and comply with regulations**.
- Different **components of interest** naturally present in caramels may exhibit **beneficial health effects**.
- Potential innovation in caramels could include the development of caramels that may provide **added nutritional/health value and/or contain fewer calories**.







For more information and to request the full version of the study "Caramel and Health", do not hesitate to contact us:

[communication@nigay.com](mailto:communication@nigay.com)