

Roumanie Présentation orale – 8 juillet 2009

Dear Colleagues, it is a real pleasure to attend this symposium on “Food for the future” within the framework of the State visit.

I hope you are not too hungry, at this time, before my communication entitled **“Evolution of food design : from recipe to formulation concept”** – Slide

As you all know, Food is an essential part of life – Slide – of course without food, we could not survive. So, Food is nutrition, but it is also delight and pleasure. We can also consider, in the modern world we live in, that food is CHIEF, C for convenience, H for Health, I for indulgent, E Excitement and F freshness.

When we talk about Food, it is necessary to distinguish between homemade food preparation and industrial products – Slide

So, in contrast to cooks and chefs, whose main interests are in kitchen, Food scientists and engineers are concerned by large-scale production of high-quality nutritious foods, safe for consumption, particularly after extended times of storage.

While cooks use recipes, Food technologist apply formulation concept.

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By definition, a recipe is a set of direction with a list of ingredients for making or preparing food.

In contrast, formulation is expressed in systematic terms and concepts.

But, this is not only a terminology problem. In fact, recipes are traditionally based on empiric observations and experiments (in most cases, trial/error until achieving a good tasty result).

In contrast, formulations are based on fundamental physicochemical or biophysical principles .

Well, after this short introduction which was an attempt to explain the title of my presentation, let us look at some practical aspects of food formulation engineering.

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We scientists, engineers and technologists have to meet the challenges to provide the basis for the production of delightful products and to deliver all the CHIEF requirements

The first challenge is to consider the different aspects of food complexity.

Then the other challenges are related to the different stages of food production

- selection of raw materials and understanding their properties and their limitations
- ingredient preparation (developing ingredient, learning to manipulate and also find the best tools to integrate the ingredient into a specific mixture or composition)
- processing (all engineering techniques – mixing, evaporation, etc. must be done to perfection)
- packaging (a very critical stage in food preparation, manufacture and storage, and, as emphasised by Frank De Vlieghere a way to innovate)

As time is a limiting factor, I will only focus in my presentation on the first three points : Food complexity, selection of raw material and new ingredient development (those are related to my own research activities).

So, first of all, let us talk about food complexity – Slide

A food product typically contains many classes of molecular components. Some are present in large proportions (water, lipids, starch, proteins), other in small or trace amounts (for instance, emulsifiers, flavours, vitamins, ...).

Formulated food products are very complex systems in which molecular interactions among different ingredients dictate the structural and textural properties of foods.

Here is an example to illustrate food structural complexity – Slide

This product is easy to eat but not so easy to design and fabricate. Indeed, you have a first layer of chocolate-like coating fat, biscuits, aerated filling and liquid filling.

When eating this kind of confectionary (sweets), did you ever ask the following questions:

- How do they get this soft centre inside the chocolate layer?
- How do they prevent the coating breakage during shipping?
- How do they limit the transfer of water or flavour from the filling to the biscuit?

We collaborate in Gembloux Agro-Bio Tech with private companies to solve this kind of problems. For that purpose, we are helped by biophysics techniques.

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Then, foodstuffs are governed by the rules of soft condensed matter physics but with all complications related to real systems. It means in fact that food science profit enormously from parallel developments made in biophysics, materials science and nanotechnology. For instance, we use in our laboratory DSC, X-ray diffraction, NMR. Of course, these techniques were not initially developed to study foods.

But how can we conceptually approach the heterogeneity of foods?

To answer this question, I would like to present a formal system of classification proposed by Hervé This, a French scientist, to describe multiphasic systems and physical microstructure. It is worthy to note that Hervé This is also the father of a quite recent discipline called “Molecular Gastronomy”.

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The formalism uses 4 letters corresponding to edible phases and 4 connectors corresponding to operation.

Concretely, this formal system of classification allows us to physical microstructure of every food product.

For example, it is possible to demonstrate that the 451 classical French sauces can be broken down into 23 distinct types (from very simple system to very complicated).

I would like to point the red formula out (Sauce Albert : $(H+S+(E/S))/E$).

The system also allows the creation and pairing of billions of novel, potentially tasty products! (by randomly generating a formula describing the structure of a previously nonexistent product).

Being aware of the complexity of the target product, the next step is the selection of raw materials and ingredients.

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The choice of all raw materials has to be done according to the following constraints :

- Law and food legislation
- Financial cost
- Nutritional quality
- Sensory properties
- Physicochemical properties

Slide

These have to be chosen according to their technofunction (or technofunctional properties). Generally speaking, the technofunction is the utilitarian function of a thing (concept used for instance in archaeology). So, in food science, technofunctional properties of ingredients encompass those physicochemical attributes that make them useful in food products.

The main technofunctional properties of proteins are presented in the following table. For instance, you can see that some proteins (muscle, egg and milk proteins) present gelling properties. Food systems interested by this properties are meat products, cake, bakeries, ...

Another way to illustrate this property. The famous Belgian artist, René Magritte, could have seen functional properties of proteins and gelation like this.

Slide

« Ceci n'est pas un œuf ». This is not egg. This is a gel of whey proteins. That means that whey proteins can replace egg albumin in some food formulations where gelation is requested.

We need of course techniques to assess technofunctional properties.

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It is now interesting to speak about a concrete formulation. Let us for instance compare the recipe of homemade mayonnaise and the formulation of industrial light mayonnaise.

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To prepare your homemade mayonnaise, you need ...

Beat ingredients together, except oil. Then add oil drop by drop. Slowly ...

The result could be interesting but be careful “Do not keep longer than 1 week”.

The industrial formulation now - Slide

Typically, a mayonnaise can be described by the following formula :

H/E. To create this emulsion, you need a large amount of oil. Indeed, oil plays an important role on the product structure and texture – Slide

When you increase slowly oil content, you create smallest and smallest drop which by interaction will give its consistency to the product.

So if you want to formulate a light mayonnaise, you will need to replace oil by water and thickeners to obtain similar texture.

In some cases of very low content (some dressings have now less than X% fat), you even have to change the initial formula to a gelified emulsion.

In red, ingredients not in a homemade mayonnaise. We find a selected oil (for instance colza, soja – rich in Omega 3), thickeners (xanthane, ..., we can also use inulin which forms fat mimetic gels), preservative (antimicrobial,

antioxidant) to increase shelf life stability (in relation to highest water content for light product).

Finally, I would like to speak about ingredient development and more particularly about cracking.

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Cracking of agricultural raw materials allows us to produce new ingredients.

Cracking can lead to clean label ingredients and provide added values to agricultural productions.

Cracking consists to fractionate into specific constituents in order to concentrate specific functionality.

Do not worry, I do not work in the car industry. Here are the main starting raw materials we use in Gembloux for cracking - Slide

Animal products: milk, egg. Vegetal ones : Cereals (wheat, spelt, oats), sugar beet leaves, date, flax seed, pea.

I will only speak about the blue items. For the other, please go to our website.

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As milk cracking is an old topic (butter or cheese processing is already milk fractionation, our research on dairy components are more focussed.

So, we have developed a spin-off project on the extraction of proteose-peptone. This proteic fraction presents interesting technofunctional properties (interfacial properties, foaming and emulsifying) but also biological properties (lipase inhibition).

Concerning the milk lipids, we recently took a patent on a mlk ingredient enriched in polar lipids (phospho- and sphingolipids) for nutraceuticals (cholesterol reduction, cancer prevention).

Some of our relevant publications in this field are listed in this slide.

My most important collaboration project concerns Tunisian date.

Starting from this fruit, we extract oil from pit, but also fibers, pectin and proteins from flesh (pulp).

Last example, pea fractionation. The initial pilot-scale process was developed in our laboratory. It allows to obtain a pea protein isolate, fibers (external and internal), starch.

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In 1990, our industrial partner started industrial production on the basis of this research

In conclusion, Food science has been evolving in line with the progress being made in other branches of soft condensed physics.

So, Food technologists are now able to understand food complexity and select appropriate ingredients on the basis of their technofunctional properties.

In fact, we are moving from a period where the emphasis is shifting from understanding food properties to using our knowledge to design and fabricate novel structures.

The challenge for the future will be to meet the growing expectation of consumers : convenience, good taste and healthful qualities in foods

So concerning this last point (healthful quality), I am sure that with the slogan “nutrition for improved health”, the challenge for the future will be to incorporate nutraceuticals in optimized formulations leading to improved bioavailability and bioefficacy. The food matrix engineering (especially physical state) will be deciding factor for that purpose.

But anyway, let me remind you that our main goal remains the consumer pleasure!

Of course, we are open in Gembloux Agro-Bio Tech to international collaborations to meet all these challenges.