

FIPDes

Food Innovation & Product Design



FIPDes Day 2013 International talents in Food Innovation and Product Design

Students' Book of Abstracts



FIPDes
Food Innovation & Product Design



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WELCOME TO THE FIRST FIPDES DAY!

FIPDes ? This wonderful adventure began some years ago. Let me tell you the story.

Once upon a time, there were students from all over the world who wanted to study in the field of food, cooking, science, innovation... At that time, the link between sciences and culinary creativity had been more broadly recognized, and it was clearer that this link was important for the food industry; within the food industry, and in the public, it was felt that food engineers really needed some understanding of the three components of food : technique, art, social link.

Students wanting to learn? Wonderful! Students ready to cross the world to get a first class education in food engineering? Obviously an answer was needed. And this is how the four core partners of FIPDes met. All of them were facing the same questions, and it was felt that each of the four partners could contribute with specific, and complementary forces to a first class educational programme. It is quite remarkable that within two proposals only, the European Community accepted our common programme. This could even be considered as a sign for something important.

By the way, building this programme was (and still is) really exciting, because it's an answer to the French writer Antoine de Saint-Exupery, who said once : « If you want to create harmony between men, make them do something together ». In order to create this Erasmus Mundus Master Programme, we had to overcome our idiosyncrasies, our cultural particularities, our individuals tastes for science, or for technology, or for technique... We have to be open to an « international culture », and this is clearly a big advantage for FIPDes students : instead of being trapped in one particular food culture, they are now exposed to very different ideas. It is not a scoop to say that the food in the north of Europe is not the same as in the south, not only in terms of particular food items, but also in terms of relationship of the human beings and food. There is no such place as FIPDes for giving to students an open view on food.

What is « good food » ? French people would consider frogs and snails along with stinky cheese, whereas Italian would put much emphasis on different qualities, such as the freshness of vegetables, they would insist on oil, but Irish or Swedish would on the contrary insist on butter, milk, cream, fish, smoked products... Imagine the students in the middle of this : they can be fully aware of the specific qualities of food ingredients, in order to build more universal good food. In the army, it was frequently said that sailors were more « intelligent » than other soldiers, because they could see more countries and cultures. The same for the FIPDes students, which, on top of this advantage, come from all over the world ! The multiculturally of the team is not only from teachers, but also from students ; students who live together for two years, having the feeling that they make a very particular group, being heavily selected before coming... and one should never repeat enough that the quality of institutions is based on the quality of the individuals making the group.

Why a FIPDes Day ?

FIPDes being created, two years ago, we had the pleasure to get the first students in September 2011, which means that this first group shall now receive their Master diplomas. But remember that FIPDes is very specific, and the partners do all they can to always improve the curriculum. Simply giving a diploma ? This would be rather dull. No, instead, we had the feeling that top engineers had to behave differently, more actively, and this is how this FIPDes Day was created.

Of course, in a family, there are different points of view, and this is what makes the family life pleasant. Within the FIPDes context, the various groups are the students, the teachers, and the various partners, from the industry or from the academy. A « feast » had to be entertaining for all !



For FIPDes, we have the idea that sciences and technology is the main thing, so that a feast should be focused on this. We also have a passion for results, not only words, which is why we decided that results should be shown. And as students had made projects, during their two year curriculum, why not propose them to explain what they did ? Here, it's probably the best place to repeat that an idea in a closed cabinet is not an idea. An idea becomes an idea only when it is implemented, shared, distributed, patented, sold, exchanged, used, improved... and this means that communication is a key factor of the education of top engineers. A feast, in the FIPDes context, had to be a day with a lot of ideas exchanged, and this is how the programme of the day was built. Sharing, sharing, sharing... At FIPDes, we have a dream : imagine a table (being systematic, isn't it a key advantage for engineers), with rows called « students », « industry partners », « academy », « teachers », « administration »... and the same for columns, and imagine that we make a cross in the cells when the two parts are discussing (on food science and technology, on food innovation and product design). We shall be proud if we succeed putting crosses in all cells of the table.

By the way, I know that it is useful to discuss somehow the words « science », « technology », « technique ». The last one is of the utmost importance, because « technique » comes from the Greek *techne*, which means « to do » ; and it's true that no food exist when it is not produced. However, this is done by technicians, not engineers. For engineers, they have to practice technology, which means the improvement of technique, using science or not. Some years ago, I proposed to call these two kinds of technology « global », and « local ».



Science ? Indeed this means only knowledge, and we shall distinguish clearly among the different kinds of sciences. There are sciences for humans and for societies, and there are « quantitative sciences », i.e. physics, physical chemistry, biology... For example, molecular gastronomy is a quantitative science, not technology, not cooking (in particular, it should not be confused with « molecular cooking », or with « note by note cooking », as we shall see later).

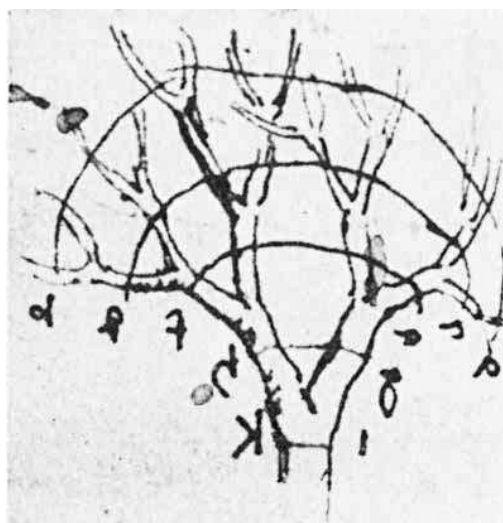
Quantitative sciences ? Their method is known, since Francis Bacon (to put figures everywhere) and Galileo Galilei (make experiments, think that the world is « written » in mathematical language). Indeed the whole method lies in : (1) observe a phenomenon ; (2) quantify it ; (3) summarize the data into synthetic laws ; (4) look for the mechanisms behind the laws ; (5) test the experimental consequences of the theory, in the hope that you will find how it is wrong. Indeed, this last characteristic of quantitative sciences can make us very optimistic about innovation : as science will have no end, always improving, it will bring new knowledge, of which talented engineers will make innovation. Yes, we can have faith that science will give the basis for innovation at all times... and this is why our educational programmes at FIPDes should be always linked to the more modern scientific knowledge.

Excellence, creativity, innovation

At this point, we have to discuss the question of excellence, because this word is in every mouth, those days, in the academic circles as well in the industry. In the end, nobody trusts the word... but if we don't say it, about FIPDes, we have the risk to be considered as less than others. And we are not, on the contrary. I know that teachers and students together do their best, in order to make a lively community of knowledge and skill ! I know that the FIPDes students are strongly selected, among hundreds of candidates. I know that their educational programme is very full.

But all this are words. The best demonstration of the excellence of FIPDes is to be given during the FIPDes Day : the proof of the cake is in the eating. Here, there should be two demonstrations : one about the content, and one about the communication skills. Are not engineers specialists of working in teams, of dealing with the complex human material. Of course, technical skills are important ; of course scientific knowledge is the firm ground on which technology can rise, but humans, wonderful humans... If we want to build a boat, let's learn to dream about the infinite sea...

Finally, I would like to insist, about the « engineer ». Remember that Leonardo da Vinci was of this kind, always considering possibilities in the world, always trying to understand, in order to do ! For example, how could he draw trees better than others ? He analyzed that the sap was a liquid, and that liquids can-



not be compressed : the rate of sap before the separation of two branches should be equal to the sum of the rates in each branch, and this leads to a particular law, in terms of diameters of the branches, on pictures. He could spend hours behind a bridge, just looking at the vortices of water, in order to understand how to represent them, i.e. trying indeed to understand liquid flows, are the visual representation is one key component of understanding in general.

Concerning innovation, also, the world is sometimes worn out. But to us, at FIPDes, it is not. It's not a sole word, but also methods, a certain way of thinking... For innovation, one needs culture, and more precisely a culture of innovation. Of course, very modern courses are needed, as this particular example shows. Imagine that you teach the «laws » of sedimentation and creaming, so important in the food industry. If you just explain how to solve the equations of motion, you teach a knowledge of the 19th century, and the innovation that one can base on it would be 19th century technology. If you decide to teach statistical physics, instead, then you reach 20th century technology... but if you teach some results obtained after Boltzmann, i.e. quantum mechanics and numerical methods, then you move into the 21st century, and this is what we have to do. In this case, students can have the basis for real innovation. Education should be linked to lively scientific research !

Of course, today, engineers have to know a good deal of science, but they need more, for sustainability is a key issue. Moreover, companies are no longer run as before. There are new challenges, and we have to envision the future with more intelligence than by sticking only to technical questions. In this regard, it's important to recognize that food is not only nutrients, but also has an art component, as well as a social one. The FIPDes community is clearly recognizing this, and we have faith that, all together, with the specific intelligence of all, from students to teachers, including administration, partners, we can envision a bright future about food !

Hervé This





Comprehension and prediction of acid milk gel texture via stochastic modeling

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With recent advances in information technology and in food science it has become possible to use mathematical modeling and computer simulations to follow some attributes describing the evolution of food structure during processing. The problematic is not a simple one to address: most food matter, dairy products, such as acid milk gels are complex systems: their texture depend on various factors, including their composition or processing conditions. The aim of this paper is to present a model used for predicting some of the textural properties of acid milk gels, such as cream cheese under different processing conditions.

Introduction

In the 1990s food process modeling was mostly used to answer questions related to preservation and food safety. With advances in information technology the focus of modeling switched to other, quality related attributes, such as: moisture content, color, viscosity and more recently some attributes describing the evolution of food structure. Indeed food engineering is catching up on its circa 20 years delay compared to chemical engineering, where modeling is now part of any technical development (Perrot et al. 2011).

Food behavior is modeled as a complex system where interactions can occur between key variables at different scales (Baudrit et al., 2010). Through this more complex, but also more accurate representation of reality the aim is now to develop models that are realistic enough to be used as predictive tools of food behavior by scientists or by food industry actors. By mimicking realistic food behavior these models may help understanding the relations between processing conditions and may make predictions of certain quality related characteristics of the intermediate or final product, such as food structure or texture. In cream cheese processing the final texture may change when applying diffe-

rent processing parameters. Due to difficulties of thorough experimental product characterization along the production chain, simulation and modeling approaches can be well suited tools to gain deeper understanding of how some of the processing parameters can be related to the final structure of the product.

At the laboratory Génie et Microbiologie des Procédés Alimentaires (INRA, Thiverval-Grignon) researchers of the MALICE team have been working on multi-scale mathematical models that simulate the structure of dairy emulsions and predict some textural properties of the final product. The long term objectives of the team are: creating models that are applicable for a wider range of processing conditions and extending the portfolio of the modeled products.

Method

The report describes the adaptation of a *neutral* dairy oil-in-water emulsion structure prediction model to fit the *acid* cream cheese processing context.

This adaptation is carried out using the following sources of information: scientific articles, discussions with researchers of the field and experimental data.

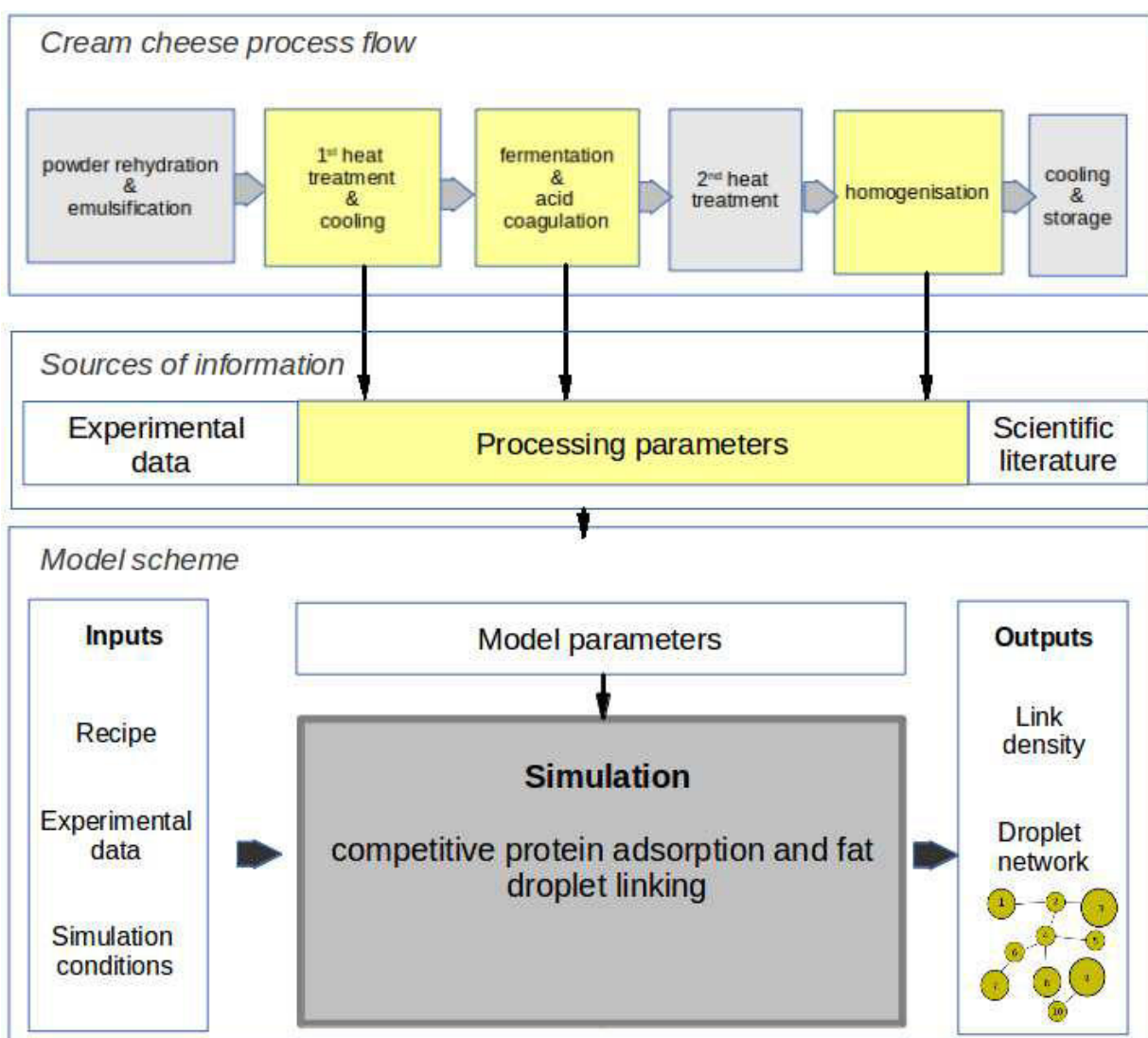


Figure 1: Incorporating knowledge - from process flow to model scheme

The re-calibrated model makes predictions of the firmness of the final products. The processing conditions applied during three selected unit operations (heat treatment, acidification and homogenization) are represented by the inserted inputs and parameters.

Structure of the model

Induced changes and food structure itself can be analyzed and described at multiple-scales: from nanoscale (e.g. primary structure of proteins, amino acid residual adsorption) to microscale (e.g. competitive adsorption of proteins on the interface → resulting interfacial composition). Lower scale simulations require high computational power and are very difficult to model for the case of real dairy emulsions due to the numerous components of such systems. Therefore a geometric, stochastic approach of simulating protein adsorption at mesoscopic scale was chosen to be developed.

In a simulated volume a hard spheres representing the fat droplets are randomly dispersed (Figure 2a). The developed model incorporates the phenomenon of competitive colonization of an oil-water interface by different protein types. The texture prediction is based on the simulated competitive protein adsorption on the fat droplet surface (Figure 2b) and link creation between the inserted elements of the simulated space (Figure 2c). The model output, the number of the links created in the simulated space may allow the prediction of some rheological properties of dairy emulsions.

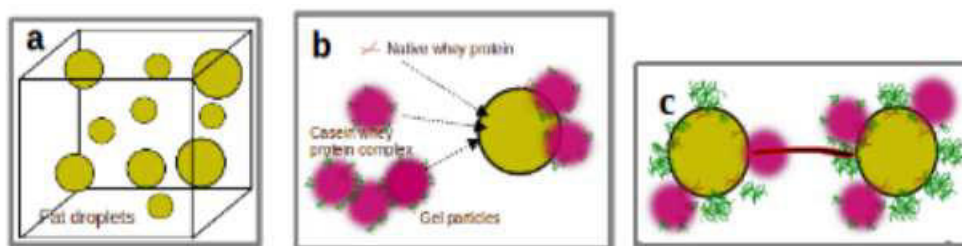


Figure 2: Fat droplets, represented as hard spheres dispersed in the simulated space (a), competitive adsorption of the different particles (native whey protein, casein/whey protein complex or gel particle (b), link creation between the droplets ©

Results

If one accepts the supposition of Dickinson (2000) that the number of bonds present in dairy gels can be directly linked to rheological properties such as firmness or elasticity, then comparison of tendencies of the results and model outputs should be possible. E. g. the stress applied to break gel structure can be proportional to the bonds present in the given matter, if supposed that the strength of the bonds are similar in all compared samples.

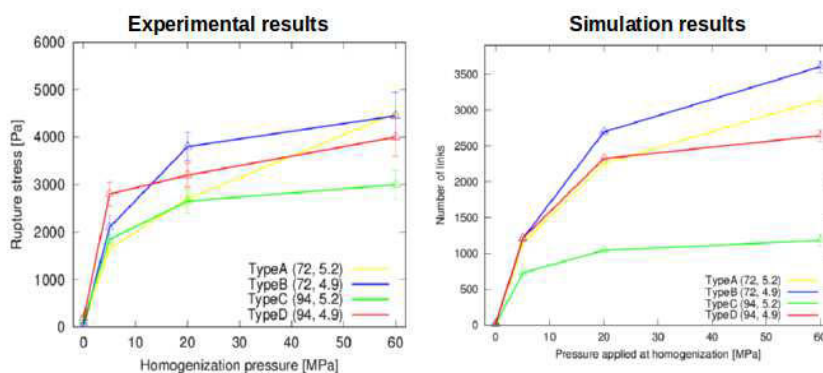


Figure 3: Rupture stress compared (on the left) to one of the simulation results (on the right) with manually set parameters reflecting the different processing conditions

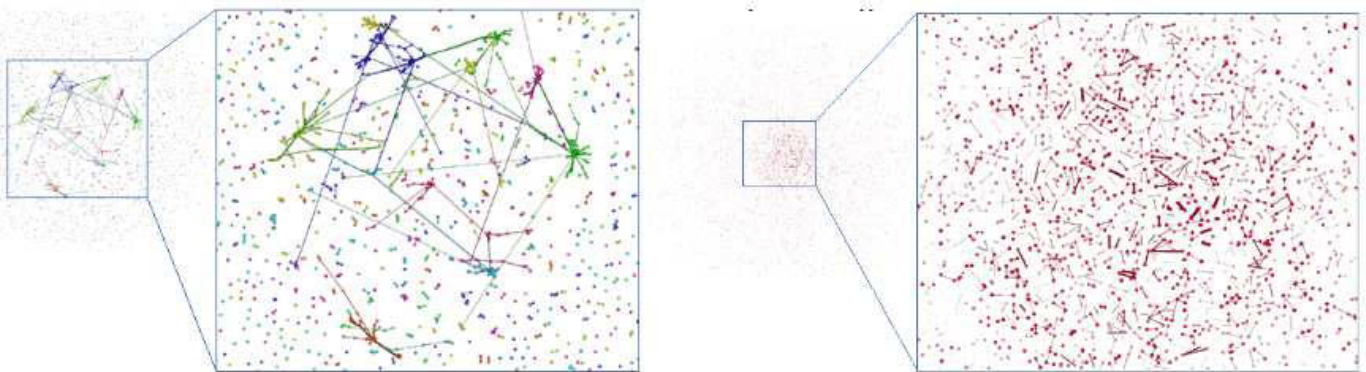
Figure 3 allows the comparison of the tendencies of measured rupture stress and the corresponding simulated outputs. The four lines reflect the four different combinations of processing parameters during heat treatment and acidification (type A,B,C and D), with 4 points on each line representing the four applied homogenization pressures. With the given inputs and parameters the model seems to well respect the increasing firmness of products with the increase of the homogenization pressure. Also the relative positions of type A,B,C and D are well predicted, the obtained result seems coherent with experimental data.

The analysis of the simulated fat droplet networks as graph structures is an interesting direction and it needs further exploration in the future. Hereby two examples of graph visualization are presented. representing simulation results corresponding to processing conditions of the smoothest and the lumpiest textures.

Figure 4: Graph visualization of two fat droplet networks: (the extremes in terms of lumpiness)

smooth: GEL type A (72°C, pH 5.2, 5MPa)

lumpy: GEL type D (94°C, pH 4.9, 60MPa)



Qualitative visual - thickness of lines and distance represent spacial configuration of droplets

Inter-connectivity of droplets are higher in the first network (smooth, on the right) and the average path length is longer, while type D network (lumpy, on the left) droplets tend to separate into logical clusters are slightly more than type A.

Conclusions and Prospects

Main conclusions

- the adapted model is able to reproduce similar tendencies that were shown in experimental data and in the literature (Sanchez et al., 1995).
- graph exploration and analysis is very exciting dimension to learn about the behaviour of the model, graph descriptive statistics allow to differentiate between networks that tend to have inhomogeneous textures → fat droplet clusters formation represents lumps

Further work to be carried out

- automation of graph analysis
- implementation of the cooling process, so that simulation takes into account the changes that occur in the food matter
- more experimental data needed for validation: additional experiments to characterize the rheological properties of final model cheese cake products

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Food in tubes: a “retro cool” Swedish innovation

Industrial history and consumers’ perspectives

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Introduction

A modern supermarket in Sweden today contains a large assortment of different food products in a variety of packages, designs and brands, but most of these appear to be based on food technologies that were introduced decades ago. One of these is food in aluminum or plastic tubes. “Tube food” is a fascinating facet of the Swedish food culture. From an international perspective, it is interesting how a packaging type that is not very common in other parts of the world can encompass a wide range of food products in Sweden; in markets outside Sweden, food in plastic tubes may be available, but those in aluminum tubes are rare, or even absent.

From recent studies of the Swedish food industry, it can be said that there is still a great potential for innovation in the Swedish food sector; however, food manufacturers have too little consumer insight, which can be a problem since understanding what the end consumer wants is essential in product development. Many firms do not find it easy to effectively connect with consumers and learn about them in a relevant and flexible way that would eventually lead to successful product innovations.

Despite tube food being widely available in the Swedish market, it is not well documented why it is commonly consumed; there is a knowledge gap regarding consumer behavior in this product category. Also, unlike other product-package categories that are present in the market, such as ready-to-eat meals, frozen food, etc., tube food and its emergence in Sweden has not been thoroughly discussed in existing literature.

The purpose of this thesis is to look at the historical background of tube food in Sweden and to understand the perspective of current tube food consumers. Aside from determining what tube food products Swedish consumers are currently buying, the thesis aims to discover the insights on why they buy it. By knowing the values and meanings that tube food gives to the consumers, we get an understanding of how consumers think and feel about this category; thus,



marketers can create more effective marketing strategies and product and packaging developers can apply this knowledge of consumers' intrinsic motivations to their product innovations.

Methodology

Since tube food consumption in Sweden is not yet a well-defined phenomenon, an exploratory research was done through a qualitative approach, involving literature review and empirical research in the form of in-depth interviews with professionals in the food and packaging industries, and in-depth interviews with tube food consumers.

Relevant literature about historical data on tube food was not available, thus, secondary information and personal insights were instead collected through semi-structured, in-depth interviews with current and retired professionals in the tube food industry and the packaging industry, such as employees from Abba, Kavli, Tectubes, Nestle/Findus, and Tetra Pak.

Twelve tube food consumers, with varying consumption habits and frequencies, were interviewed in this study. In understanding the consumer behavior, it should be noted that there are many organizing principles offered by psychologists that enable researchers to make sense of how people live and make choices, and one of these is by looking at their values. For the purpose of this study, the framework of the *means-end chain* model was chosen to investigate the perspectives of the tube food consumers. All the learning and understanding from the consumer interviews were collapsed into "sound bites" and were organized into three categories: elements (or product attributes), consequences (or benefits), and values; with these information, a graphic model in the form of a *value diagram* (also called a hierarchical value map) based on the means-end chain theory was constructed to try to understand *why* tube food is being consumed today.

By investigating the historical background of tube food and by studying present consumer perspectives through the consumers' insights on product attributes, the consequences and benefits that they get from tube food, and the underlying values that are associated with it, the study aims to explore and understand the phenomenon of tube food consumption in Sweden.

Findings

Industrial History

The rise of tube food in Sweden occurred during the years after the Second World War. This was seen as an important period involving the growth of the modern food industry in Sweden, when technological innovations seemed to coincide with social and cultural innovations. After the war, mass-produced food started to be developed in Sweden and sold at reasonable prices, following the US as a model. Modern food packaging evolved with the society and the food industry, as the need for more individually packaged goods surfaced.

In the case of tube food, the technological change was the introduction of this new way of processing and packaging food into tubes, with examples like caviar and soft cheese spread. The timing was right, as this was also a period when the fishing industry in Sweden was booming. A natural connection seemed to have existed between the caviar producing companies in the harbors and the tube manufacturers in the surrounding area. Eventually, the range of food applications for the tube package widened, in the way that a packaging system can often drive product development by being tested on a variety of products, and then later adapting the package or further developing it.

Aside from technological advancements, consumer culture also developed significantly in Sweden after the Second World War and in particular during the 1950's. The social and cultural change was the burgeoning of a new consumer culture. There was a strong belief in the future, and increased welfare led to increase in consumption. Branding became more important as well, and Kalles Kaviar, which is one of the most important tube food brands until today, was established during this period.

Consumers' Perspectives

The current tube food products that are being consumed can be grouped into two categories: (a) spreads for sandwiches, or (b) condiments and sauces. Tubes were perceived to be a practical package for food items that are being spread, such as caviar and soft cheese on sandwiches, and consumers believe that tubes have many benefits when used for this purpose. It is a quick, simple, mess-free way of putting caviar and soft cheese on bread, without the need for a knife or spoon; moreover, it can be a fun way of creating nice-looking patterns on a sandwich. The second category of tube food consists of condiments and sauces, the most common of which are mustard, mayonnaise and concentrated tomato purée. These have more variety in terms of consumption situations, but they can basically be consumed directly (e.g. mustard on sausages), mixed with other ingredients (e.g. mayonnaise-based sauces), or used in cooking (e.g. tomato purée as a flavor enhancer in tomato-based dishes).

There is no single way of completely understanding a phenomenon as broad as tube food consumption, but one useful approach was by looking at the links between high-level perceptions about tube food (such as values and benefits) and actual attributes or elements of the product experience. The main product attributes of tube food that seemed to be most significant to the consumers are: brands, package type (tube), package size, and package material. Each main attribute leads to more specific attributes, which then leads to different responses about functional, behavioral, and emotional consequences or benefits. A more in-depth understanding of tube food consumption was achieved by ultimately determining the specific values that are associated with the tube food category. Values are important to study because they can influence a consumer's attitudes and behavior by serving as preferential standards in his or her mind. The following terminal values, or end-states of existence, seemed to be associated with tube food consumption: *inner harmony*, *sense of accomplishment*, and *comfortable life*; in addition, the instrumental values, or preferable modes of behavior needed to achieve the consumers' desired end, were: *tradition*, *family*, *clean*, *fun and adventure*, *health*, and *social responsibility*. A summary of the consumers' perspectives is shown graphically in a *value diagram*, shown in the figure on the next page.

In essence, Swedish consumers consume tube food because it is seen as a product that caters to particular needs and provides certain benefits, and the value diagram was able to show the links between the tangible product-package attributes (e.g. package type, package size) and intrinsic motivations, which are the perceived benefits and values (e.g. comfortable life, health). It should be noted, however, that these results are not meant to be representative of each respondent's personal values, but were meant to show the understanding of the aggregated responses of all the consumers.

Recommendations for further research

Although this research was meant to be exploratory in nature, it was valuable to look forward, and to initiate a possible discussion of its implication on product innovation and marketing. After this preliminary study of getting to know tube food consumers and trying to understand their product knowledge on tube food, further research may be able to translate this study's findings into realizable, but innovative ideas.

The results of this research can be used as a springboard for further studies—a next logical step would be to quantify these small-scale results to a larger scale audience of tube food consumers in order to confirm the findings quantitatively.

For further studies, perhaps it can be also be explored whether tube food, or products considered to be similar with it, may succeed in other cultures that have the same value constructs as the one concluded from this research. Another approach is to investigate several key “mega trends” in relation to tube food product or packaging innovations, such as the need for healthier alternatives, increasing demand for convenience, and changing demographics such as the ageing population.

More rigorous studies may be done later on to translate this study's findings into realizable product or packaging innovations, with the ultimate aim of creating a strategic product platform that would prove to be relevant to today's tube food consumers.



Need of the market information in the B2B Packaging Industry Insights into the Milk Formula Market in the Asia-Pacific Region at A&R Carton AB

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As the ultimate demand of packaging comes from end-users, the importance of consumer and market information has risen in the packaging industry. A folding-carton packaging targets milk formula product has an opportunity to expand its market share in the Asia-Pacific region due to an increased demand, thus it is essential for the packaging industry to understand the relatively unknown emerging market. A systematic international marketing research and industry-specific indicators were designed, which revealed many valuable insights for the carton packaging industry. As a result, a careful consideration of consumer convenience, safety and retail distribution change is recommended to thrive in the Asia-Pacific milk formula market.

Introduction

Packaging industry is an intermediary business that often outsources materials, transforms it into packages, and then supplies it to their customer such as the food industry. The business handles both internal and external relations to retain current direct customers as well as to win potential customers. In general, the packaging industry has a business-to-business characteristic that works on the needs of their direct consumers. In addition, it is equally important to know the consumer market since the demand ultimately comes from the end-consumers. Therefore, knowing the end-user needs provides a better perspective and understanding of the direct customers. The case company, A&R Carton, has a strong base in European market that produces customized folding cartons for various consumer goods. One of the main targets is a milk formula product, which the Asia-Pacific region has played an important role in recent years. Since the region is unknown market to the firm, it is crucial for them to conduct a preliminary market research to evaluate the market potential before expanding their market territory.

Objective

The two main purpose of this thesis is to:

- Investigate the nature of packaging industry to understand the need of market and consumer information in the business-to-business settings.
- Identify the trends and prospects of the milk formula market in the Asia-Pacific region in response to the need of the market research at the case company.

Method

A single case study with abductive approach was used to understand the need of market information. The case study was based on two primary data sources, which are interviews and observations. The collected data followed a thematic analysis methodology to categorize meaningful insights.

After identifying the need, a 3-phase systematic international marketing research was structured. It was designed firstly to distinguish promising markets; secondly to conduct in-depth market research and finally to find similarities across the Asia-Pacific region. The overall research used indexing and ranking method^{1, 2} as well as the thematic analysis, based on secondary data sources such as market intelligence reports and literature review.

Results

The case study showed the drivers of collecting market information in the B2B packaging industry. The biggest motivation was to have a better understanding of their direct customers. Export markets such as Asia were valued as the company is export-oriented, but the scarce market information and cultural differences in the unknown markets hindered the geographical expansion of the business. In addition, there were certain obstacles in the company to conduct a substantial market research that came from the business settings, which gives rise to the necessity of the market research. Considering the identified needs, a systematic market research was carried out in response. It is consisted with three interdependent phases as below.

Phase 1. Preliminary screening

The purpose of the first phase is to identify the markets that have a high attractiveness for the sales potential. As a start point, eleven markets in the Asia-Pacific were chosen, which were repeatedly appear in the industry-specific market reports. In order to assess the potential of those markets, certain variables were developed based on reviewing the literature and market reports. The variables were evaluated and weighted by using the formula below to rank the markets.

$$X'^{ij} = \left[\frac{X_{ij} - \text{min}_i}{R_i} (99) \right] + 1$$

X_{ij} : Average score of country j on dimension i

X'^{ij} : Scaled final value of country j for the dimension i

Min_i : Minimum value for dimension i

R_i : Range of dimension i

Table 1. Dimensions and measures of the Asia-Pacific market potential

Dimension	Weight	Measures
Market size	5/10	<ul style="list-style-type: none"> • Retail value (MARKETVALUECUR) • Total volume (MARKETVOLUMECUR)
Market growth rate	3/10	<ul style="list-style-type: none"> • CAGR growth rate forecast retail value (MARKETVALUEFC) • CAGR growth rate forecast total volume (MARKETVOLUMEFC)
Consumption capacity	2/10	<ul style="list-style-type: none"> • Birth rate (MARKETCAP)

As a result of the first phase, seven markets were prioritized while the other four markets (Table 2) were disregarded due to their low-attractiveness.

Table 2. Preliminary market selection result

	Score	Index	Rank
China	8.5	100	1
Indonesia	3.9	41	2
Philippines	3.1	31	3
India	2.7	26	4
Vietnam	2.7	26	5
Malaysia	2.4	23	6
Thailand	1.9	17	7
Singapore	1.1	6	8
Taiwan	0.8	2	9
Japan	0.7	1	10
South Korea	0.7	1	11

Phase 2. Individual market research

The individual market research was conducted based on the indicators developed through reviewing the relevant business intelligence reports. The indicators are categorized into five main areas, which are demographic, market, product, consumer and government policy towards milk formula.

Table 3. Market indicators in the selected Asia-Pacific region

Category	Indicator
Demographics	Birth rate
	Female labor participation
	Exclusive breastfeeding rate
	Urban population
Market	Market retail value RSP
	Company share
	Distribution channel
Product	Brand share
	Packaging prevalence
	Expenditure per capita
Consumer	Attitude
Government policy	Milk formula-related

Phase 3. Multinational market research

The last phase was investigated to spot the similarities across the region. Some commonalities were noticed and categorized into themes. Urbanization and demographic changes have transformed the consumer life style, which favored the milk formula use. Parents are health-conscious and proactive to find the best alternative to breast milk when breastfeeding is not a preferred option, and this behavior increased the market value in recent years. The milk formula products are mainly distributed in the grocery stores but online retailers are steadily gaining its popularity due to the convenience. When it comes to the packaging, bag-in-box and tin can are the two most popular formats in all the markets.

Discussion

The systematic market research revealed three remarks for folding carton to fully consider, which are consumer convenience, product safety and retail distribution channel change.

Firstly, as the consumers demand product convenience under the daily pressure in urban life, the recent packaging developments have been focused on enhancing the product usability; easy-opening/-closing feature, different lid design for scoop storage and emergence of single-serve packs for on-the-go use were noticed. The melamine tainted milk formula scandal upraised safety concerns around the globe, which brought the second remark. Although it is a must, a packaging ensures the product safety (i.e., tamper-evident packaging) could have an added value in certain markets like China. In other words, a packaging can play a communicative role with end-consumers by ensuring the quality maintenance throughout the shelf life. The last insight is the change in retail distribution channels. The popularity of large retailing operation brings a fierce competition on the shelves. As the packaging is a medium that draws the attention of end-consumers in the retailing operations, increased shelf space is likely to positively drive the packaging development to win the intense shelf competition.

Although the need and practicality of the market information was confirmed, certain barriers were noticed that discourages the follow-up market research initiatives in the case company, which came from the nature of B2B settings. Since the most business cases start upon the order of the direct customers, not much attention is given to the end-user markets. Another main obstacle was the change in organizational structure due to the downsizing trend. The lean structure merged marketing department into another, which reduced the role of marketing department such as conducting the market research. The findings were similar to the problems that had been reported in the previous studies about B2B industry.

Conclusions

The case study revealed a clear need of the relevant market information in the business-to-business packaging firm to win the potential customers. The in-depth market research was beneficial for the carton-packaging industry to target the Asia-Pacific region as it provided valuable remarks based on the solid data. The findings suggest the packaging industry to focus on three main aspects, namely consumer convenience, product safety and distribution channel change.

However, it was problematic for the packaging industry to collect and update such market data in the future due to several difficulties transmitted from the business environment; therefore it leaves a further research area to facilitate the information gathering under the current business environment.

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Market Trends and Product Development of Tray-Sealed Single Serving Ready Meals in Sweden, Taiwan and China

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The study was conducted by thematic analysis from secondary data such as literatures, reports and website, and ten interviews which respondents' backgrounds are experts from ready meal and its packaging related areas. The whole paper followed the structure built from the analysis: servings and portions, distributions, ready meal market and its evolution, consumer perspective, ready meal packaging and its evolution, trends of ready meal and trends of ready meal packaging. From the results, the current situation, trends of ready meal, and trends of ready meal packaging from each country were summarized. By learning from each other, it identified the opportunities to help both the local and foreign clusters to enter a certain country market.

Introduction

Due to the socio-economic evolution such as increasing women workforce and a growing number of single households causing the needs for timesaving, convenience, and minimal food preparation, Ready Meals has become one of the most popular meal solutions. According to Euro-monitor International (2013), the retail value of ready meals attained

US\$92.2 billion in 2012 around the world, and it is expected to maintain this momentum during the forthcoming years up to 2016. Besides ready meals itself, ready meal packaging is also important, because sometimes, it is hard to separate trends in food processing and food packaging as each can improve the other. In this research, Sweden, Taiwan and China were chosen to be the focusing countries since they are big and potential ready meal markets and it is interesting to see both the Taiwan market and the China market due to many cultural similarities. All these phenomenon led to the main questions of the study, what are the different markets and trends of tray-sealed single serving ready meals in Sweden compared to Taiwan and China? Moreover, the aim of this study was established, which is that by comparing and understanding market trends and product development of tray-sealed single serving ready meals products and packaging in Sweden, Taiwan, and China, one might identify opportunities by learning from each other.

Method

Ten semi-structured interviews were conducted with ten experts from ready meal and its packaging related area, and the data was collected from interviewing transcripts and notes and secondary data such as literature, reports and websites. Using thematic analysis to categorize the data into different topics with a related order to build the structure of the paper.

Results and Discussion

The results were elaborated in details following the outline from thematic analysis. First, servings and portions were discussed to certify the focus of the research. Secondly, the differences of the distribution channels between three countries were compared: in Sweden it is mainly supermarkets and hypermarkets, in Taiwan mainly convenience stores which led to the study of convenience stores in Taiwan and China. The current ready meal markets in three countries are discovered and compared at the third part to have a general idea of the current situation. Since the product development procedure generally is very market and consumer oriented, so the consumer perspective have been discussed in the fourth section, including the target consumers, consumer behavior and whether the consumers care about the packaging or not, which led to the fifth topic, ready meals packaging and its evolution. After, it's the trends of ready meal and its packaging.

From the above results, the current situations, the trends of ready meals, and the trends of read meal packaging were concluded (Table 1).

The main current situations need to be noticed are: (1) Ready meals markets are still growing. It keeps growing in both Sweden and Taiwan, and it will grow a lot in China since it is at the beginning stage in there. (2) The huge difference between the main categories of ready meals. Frozen in Sweden, chilled in Taiwan, and probably will be mainly chilled in China. (3) Tray-sealed packaging has grown rapidly in Taiwan in these three years.

The trends of ready meals can be categorized on three main streams: (1) Healthy: Organic, local produced, vegetarian products are increasing, and also the consumers are more aware of the nutritional value of the products. (2) Convenience: In Sweden, there is a new concept "shop-in-shop" from ICA To Go providing on-the-go single serving ready meals, and the ready meal sales in convenience stores is also increasing. In Taiwan, convenience stores started to "restaurantize," giving a dining area for the customers to consume the products they bought. (3) Different ranges and choices: Premium brands might occur. New flavors and international exotic cuisine are always the factors attracting the consumers. Component food might also be in the trend, which can offer different kinds of components such as meat, sauce and carbohydrates to let the consumers make their own combinations, in addition, having some special meals for some particular demands like elders.

Concerning trends of ready meals packaging, these are: (1) Function: Intelligent packaging, like Micvac, which can pasteurize and vacuum the chilled ready meal in a tray by microwaving to prolong its shelf life up to 30 days, and Culidish, a developing packaging that allows different compartments of the meal to be microwaved in one package making possible that each of them reach the different desired temperature at once. (2) Eco-friendliness: the closure of the tray has changed from plastic lid to plastic film in these three years in Taiwan, and in Sweden, plastic film is the main use. It might change to bag packaging with a user-friendly and ergonomic design for reducing the material use. Besides, one of the biggest ready meal companies in Sweden, Findus, has recently launched a ready meal with the claim that its packaging only uses 60% of the material used originally.

Table 1. Summary of current situation, trends and opportunities in ready meals and its packaging

	Sweden	Taiwan	China
Current situation of ready meals	<p>EUR784 million sales in 2012</p> <p>Constant value 1% over forecast period 2012-2017</p> <p>Mainly single serving</p> <p>Mainly in supermarkets and hypermarkets</p> <p>Mainly frozen (49%)</p> <p>Price of frozen ready meal is too cheap</p> <p>Frozen: office workers and retired people</p> <p>Chilled: single household want quick good food</p>	<p>EUR687 million sales in 2012</p> <p>Constant value 4% over forecast period 2012-2017</p> <p>Mainly single serving</p> <p>Mainly in Convenience Stores</p> <p>Mostly chilled (91%)</p> <p>Chilled are mainly CVS private brand</p> <p>18-45 yrs target consumer</p> <p>Migration concerns from packaging to food</p> <p>Tray-sealed package has increased rapidly in these three years</p>	<p>At the beginning stage starts to grow</p> <p>Not too many ready meals on the market yet</p> <p>As a supplement meal: (1) not eating at the regular meal time, (2) want to have food between meals, (3) students between classes</p> <p>Mainly frozen in supermarkets and hypermarkets</p> <p>Mainly local brand, few private brand from foreign investment CVS</p> <p>Problems: logistic, safety, supply chain, cold chain, positioning</p>
Trends of ready meals	<p>Increasing sales in convenience stores</p> <p>Price of frozen increasing</p> <p>Premium brand might appear</p> <p>Varieties of meal choices</p> <p>Eco-friendly and fair-trade products slowly growing</p> <p>More different channels</p> <p>Component food</p> <p>Vegetarian</p> <p>Shop-in-shop</p> <p>Locally produced</p>	<p>Start to target elders</p> <p>Frozen will grow</p> <p>Vegetarian meal is growing for health and diet demands</p> <p>New flavors to arise interest on frozen food</p> <p>Restaurantize: providing dining area</p> <p>Demands on nutritional value might grow</p> <p>Organic ingredients for health demands</p> <p>Exotic themes in frozen to attract people</p>	<p>From supplement change to single serving</p> <p>Ready meals sales will grow especially in CVS</p> <p>Development path will be similar to Taiwan: hot food, frozen, 4°C, 18°C</p> <p>Main channel will be in CVS and hypermarket, CVS for individual size, hypermarket for family size</p>
Trends of ready meals packaging	<p>New kind appears: pasteurize and vacuum (Micvac)</p> <p>Intelligent packaging</p> <p>Plastic keeps growing</p> <p>New take-away box form Findus product (60% of original material used)</p>	<p>Focus on environmental issue</p> <p>Flexible packaging increase</p> <p>Possible change into bag packaging</p>	<p>Refer to Taiwan, Japan and other countries</p>
Opportunities encountered	<p>CVS in Sweden can try to use the develop method or concept of Taiwanese CVS to expand their business in certain stores</p> <p>Restaurantizing by providing dining area in CVS</p> <p>Launching more chilled ready meal to provide another kinds of consuming occasion</p>	<p>Having more kinds of ingredients in chilled by improving technique (ex: seafood in pasteurizing package)</p> <p>To have premium ready meals in the market</p> <p>Refers to Sweden to develop ready meal for elders and special need</p> <p>Changing to a better packaging from Sweden or other countries to improve the quality, shelf life and eco-friendliness</p>	<p>Providing ready meals services to differentiate the market from CVS, also having private brand</p> <p>To have premium ready meals in the market</p> <p>Referring to other countries' experience to develop ready meal business faster</p>

Conclusion

The opportunities are generated from the current situations of each country and the trends of ready meals and its packaging. The opportunities in Sweden are: (1) Develop more on chilled ready meals, which is still a small market and there will be more opportunities and availabilities if the products have longer shelf life. (2) Have convenience stores as a channel. One of the properties of ready meals is convenience, which the customer in convenience stores seeks, and there is already a complete supply chain and cold chain build in CVS industry. (3) Restaurantize convenience stores. Providing a small dining area in the store with seats and tables to attract more customers to buy and consume the products. The opportunities in Taiwan are: (1) Provide different ranges of products targeting different kinds of consumers such as premium brands and products for elders. (2) Change to a better packaging in both functional and eco-friendly way. Functional packaging like intelligent packaging or packaging to extend the shelf life and quality, and eco-friendly packaging by reducing the material use or using a better material. The opportunities encountered for China are: (1) Develop the whole ready meal industry. Ready meals are still in the beginning stage, so there are huge potential markets in both chilled and frozen ready meals, and the market of its packaging will also relatively grow. (2) Convenience stores provide ready meal services to differentiate the market and have their own private brand. Convenience stores will become one of the main distribution channels of ready meals. (3) Referring to other countries in order to develop the business faster.

From all of the opportunities above in each country, the food and packaging clusters can find their opportunities to expand their business in those three countries, and they could also know what can they learn from the others.

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Formulation and characterization of an eggless gluten free sponge cake model for mastering the structure and reactivity of its constituents

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A model of sponge cake with no egg, gluten and lipids was developed. The model cake was made by corn starch, sucrose, water and modified cellulose (hydroxypropyl methylcellulose). Its microstructure and physical properties were compared with a traditional sponge cake as a reference (wheat flour, sucrose, egg white, egg yolk, water). Environmental scanning electron microscopic studies showed that both cakes featured an open alveolar structure. The model cake had a completely white color and values of density, firmness and water content similar to the reference cake whereas its viscoelasticity was higher. Furthermore, the characteristics of batters using three different hydrocolloids in combination with emulsifier were also studied. In presence of emulsifier xanthan and guar gum batters showed lower batter densities whereas hydroxypropyl methylcellulose batters showed higher densities. In addition, the effect of molecular weight and chemical composition of modified celluloses in batter and cake properties were also investigated. The results showed that modified celluloses with same substitution degree but higher molecular weight produce higher batter densities and higher cake firmness. Nevertheless, no correlation was found between the consistency of the batters and the density of the cakes.

Introduction

In the food industry, food products undergo to several physicochemical changes from the raw materials to the final consumer. During the elaboration, storage and consumption, the food attributes are affected by many factors closely connected to food reactivity. Some of the reactions present in foodstuffs are Maillard reaction, caramelization and lipid oxidation. These chemical reactions play an important role in the characteristics of bakery products.

Different simplified model systems have been used to study these reactions, however, in order to study the role of the structure in the food reactivity, a model of a complex solid which mimics the structural properties of a bakery product, but inert as regards to the reactions occurring during baking, should be developed.

The aim of this study is to develop a model of a baked product with an alveolar structure (sponge cake type) able to act as support for the study of the impact of formulation and structure on the reactivity of different constituents. In order to master the reactivity of the sponge cake components, the model should be as much chemically inert as possible regarding the reactions occurring during baking and with an entirely known composition, thus, it will contain neither flour nor egg. Nevertheless, these ingredients play a key role in the structure of the sponge cake.

The strategy for developing the model was based on coupling formulation and process. Thickening agents and surfactant compounds would be used to replace the functionality of egg and gluten in sponge cake. The making process would be optimized for the new formulation. This work establishes the basis for developing an adequate support for further studies of the impact of formulation and structure in the reactivity of bakery products.

Materials and methods

Cake batter preparation and baking procedures

Reference cake batter was made by 155.30 g of wheat flour, 83 g of white egg, 72.35 g of egg yolk, 155.30 g of sugar and 34.05 g of ultrapure water using a mixer K45SSWH (KitchenAid France, Suresnes, France).

For the model cake, firstly, a hydrocolloid solution was prepared by dry mixing of 1.02 g of hydrocolloid (modified cellulose, guar gum and xanthan) with sugar in the ratio of 1:4 (w/w) and then dissolving the mixture in 123.40 g of ultrapure water at 80 °C with continuous agitation for 45 min. In the case of the modified cellulose to achieve a complete dissolution, the dry mixture was first dispersed in 123.40 g of ultrapure water at 80 °C for 5 min followed by 20 min at 15 °C (keeping continuous agitation). The hydrocolloids solution and 31.70 g of water were mixed. Then, 170 g of sugar were added followed by 170 g of corn starch.

500g of batter were prepared for each baking operation and four aliquots of 50g batter were rapidly poured into rectangular aluminium moulds (7.6*3.3*1.5 cm) and baked in the oven at 180 °C for 25 min. After baking, the cakes were removed from the moulds, left 30 min for cooling at room temperature, then introduced in plastic bags and stored at room temperature for 24 h.

Batter characterization

Density: it was calculated by dividing the weight of a standard volume of batter by the weight of an equal volume of ultrapure water. The measurement was done in triplicate immediately after the batter preparation.

Consistency: a sample of the batter was placed into a 40mL (27mm diameter) plastic tube and analysed using a TA-XT2 texture analyser (Stable Micro Systems Ltd., Surrey, UK) with a 5 kg load cell 20 min after the batter preparation. The batter was tested under vertical compression using a cylindrical probe (20 mm). The force-distance curve was recorded. Consistency was defined as the average force between 15 and 20 mm of penetration.

Cake characterization

Moisture content: it was measured by weight loss after drying in a non-ventilated oven EM10 (Chopin Technologies, Villeneuve-la-Garenne, France) at 105 °C for 16 h. It was expressed as percentage of wet basis.

Volume and density: it was determined by seed displacement method.

Texture: The cake was divided into two parts using a specific tool designed for this study. A round sample of 19mm diameter was taken from the centre of the bottom part (high of 12mm). A deformation test was carried out using a TA-XT2 texture analyser with a 25 kg load cell and 40 mm probe. The force-time curve was recorded. Firmness was defined as the force required for compressing the product by 25% (the peak force on the force-time curve). Viscoelasticity was defined as the ratio of storage deformation to total deformation and it was calculated dividing the force required to hold the samples in compression (25% strain) for 60 s by the peak force.

Microstructure: Environmental scanning electron microscope (ESEM) studies were carried out using Quanta Scanning Electron Microscope 200 (Fei, Eindhoven, The Netherlands). Samples of crumb and crust of the reference and model cakes of 0.5 x1.5 mm were taken after 24 h of storage; each sample was transferred to the microscope (10 mm of distance with the sample) where it was observed at 10 kV and 1 torr vacuum. Polarize light microscopy was also used to observe the degree of starch gelatinization. A microscope Olympus BX51 (Olympus Europe, Hamburg, Germany) equipped with a digital camera Basler A102FC (Basler AG, Ahrensburg, Germany) and two polarizers with polarizing planes oriented perpendicular to each other was used.

Results

Modified cellulose, xanthan and guar gum were used to substitute eggs and gluten functionality with and without presence of emulsifier E-471 (mono- and diglycerides of fatty acids). Density of the batter was analysed: xanthan and guar gum formulas had lower densities in combination with emulsifier. However, modified cellulose (HPMC) produced lower densities without emulsifier.

The properties of the modified celluloses are related to the chemical composition and the molecular weight of the polymers. Modified celluloses with different molecular weight and chemical composition were used to study their effect in the batter and cake properties: Methocel K4M, K100M, K250M, F50, F450, F4M, A15, A4M, E4M, and XCS (DOW Chemical Company, Midland, Unites States).

Substitution degree and molecular weight of celluloses had an effect on batter and cake properties. Modified celluloses with same substitution degree but higher molecular weight produced higher batter densities and higher cake firmness. *Methocel K4M* had the lowest density (0.394 g/cm³) followed by *XCS* (0.434 g/cm³; and *F50* (0.446 g/cm³). (See: **Fig. 1**). All the formulas resulted in higher values of viscoelasticity and water content than the reference cake. No relation between modified cellulose molecular weight and batter consistency was found; same chemical composition of Methocel but higher molecular weight did not produce higher consistency values (TA-XT2 retro-extrusion test). Moreover, no correlation was found between the consistency of the batters and the density of the cakes.

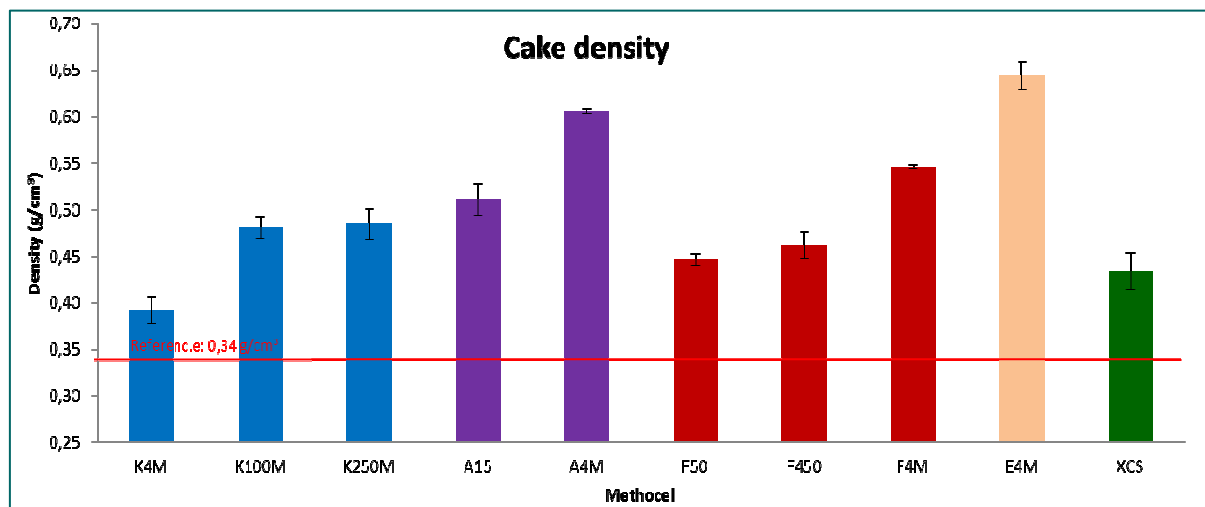


Fig. 1.



Cakes densities for different modified celluloses

In order to decrease the water content, viscoelasticity and density values of the model cake, the amount of water in the formula was reduced by 5%, 10%, 15%, 17.5% and 20% for Methocel K4M. Reducing the amount of water increased the batter density and decreased the water content of the cakes. The cake with the lowest density was obtained with 10% of water reduction (0.391 ± 0.014 g/cm³), which also had the lowest cake firmness, followed by 15% (0.446 ± 0.019) and 5% (0.446 ± 0.014 g/cm³) of water reduction.

The effect of the temperature of the hydration (for 5 min) of Methocel K4M after dispersion for 20 min at 80 °C (under continuous agitation) was also studied. **Table 1** shows the comparison between the reference cake properties and the Methocel K4M cakes after hydration at 15° and 6 °C. Hydration at 6 °C produced the cake with the lowest density. The HPMC hydration temperature seemed to play a role in the cake characteristics due to the effect of the temperature on the gel properties of HPMC.

Table 1. Comparison between reference cake and Methocel K4M after HPMC hydration at 6° and 15° C

	Reference	K4M (6 ° C)	K4M (15 ° C)
Ingredients (g/100g)			
	Wheat flour (T55): 31.05 Egg white: 16.60 Egg Yolk: 14.50 Sugar: 31.05 Water: 6.80	Methocel K4M: 0.21 Sucrose: 34.40 Corn starch (Maizena): 34.40 Water: 28.99	
Cake properties			
Density (g/cm ³)	0.34	0.37	0.39
Firmness (N)	1.72	2.03	1.41
Moisture content (%)	20.47	21.45	21.50
Viscoelasticity (%)	36.56	66.52	64.59



The reference cake and Methocel *K4M* model cake with HPMC hydration of HPMC at 6° C were analyzed by Environmental Scanning Electron Microscopic (ESEM) and polarized light microscopy. The crumb from both cakes had an open alveolar structure presenting “tunneling” effect (it can be observed as holes in the alveoli) (**Fig 2**). Nevertheless, the model cake presented higher alveoli size. The reference cake crumb featured a smoother surface than the model; it can be attributed to the presence of lipids in the reference cake and their absence in the model. Contrary to the crumb, the model cake crust presented a smoother surface. No differences were observed between the cakes in degree of starch gelatinization; the “Maltese crosses” were present in large number in the crusts and in a very small number in the crumbs.

Conclusions and prospects

An egg, gluten and lipids free sponge cake can be made using as ingredients HPMC, corn starch, sugar and water. This model cake featured similar values of density, firmness and water content to the reference cake and higher values of water viscoelasticity. Both cakes presented an open alveolar structure; however, the size of the alveoli was higher in the model cake. Starch appeared predominantly gelatinized in the crumble of both cakes whereas in the crust it largely remained in form of granules.

In presence of emulsifier E-471 xanthan and guar gum batters showed lower batter densities whereas HPMC batters showed higher densities. HPMC produced cakes with similar characteristics to the reference cake eluding the use of emulsifiers. The chemical composition and molecular weight, as well as dispersion and hydration conditions of modified celluloses, have an effect in batter density and cake properties such as density, firmness and viscoelasticity.

The formulation and process affect the properties of batter and cake; however, the properties of the batter were not well correlated with the properties of the cake. The determination of batter consistency using TA-XT2 was not adequate to estimate the efficiency of air retention during baking.; Brookfield viscosimeter and parallel plate rheometer have been extensively used in the bibliography for this objective, whereas TA-XT2 has been used mainly for cake texture characterization. Therefore, a different method to estimate the efficiency of air retention of the batter should be used in further studies.

Due to the different properties of the modified celluloses, formulas with combination of different modified celluloses could improve the properties of the model cake by optimizing the level of air entrapment as well as providing optimum cake batter viscosity to achieve low density cakes.

In order to validate the sponge cake model developed in this work, it will be necessary to test its reactivity toward the chemical reactions that will be the focus of the next steps of the research work (e.g. Maillard reaction). In addition, studies of mass and heat transfer will be necessary to better compare the model and reference cakes.

Moreover, the model cake has to present enough degrees of freedom in order to be able to change structural characteristics without changing the chemical composition (e.g. size of alveoli). This double validation (towards structure and reactivity) will make it possible to use this model cake as an inert support for the study of the impact of formulation and structure on food reactivity.

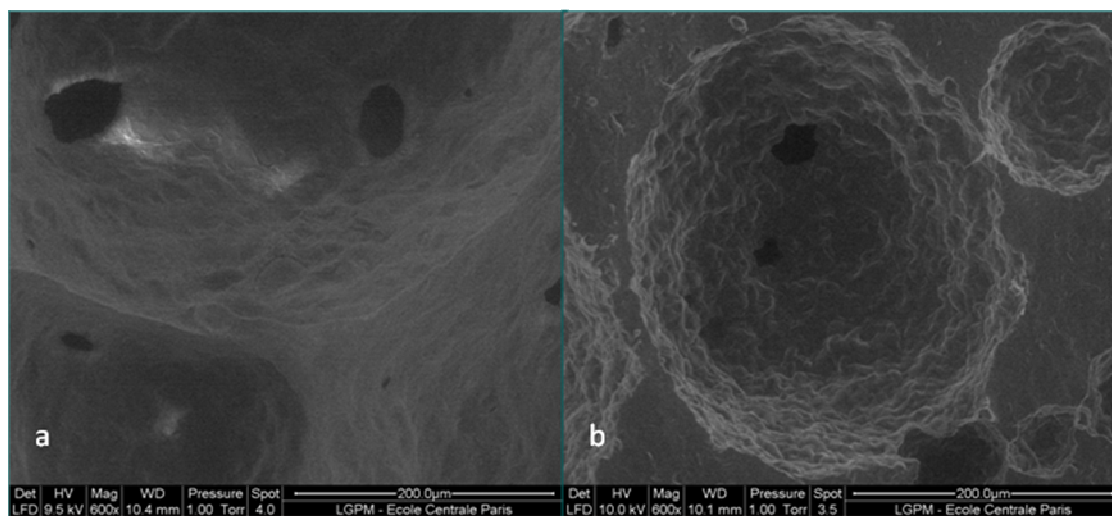


Fig 2. ESEM micrographs of cake crumb: (a) reference; (b) model

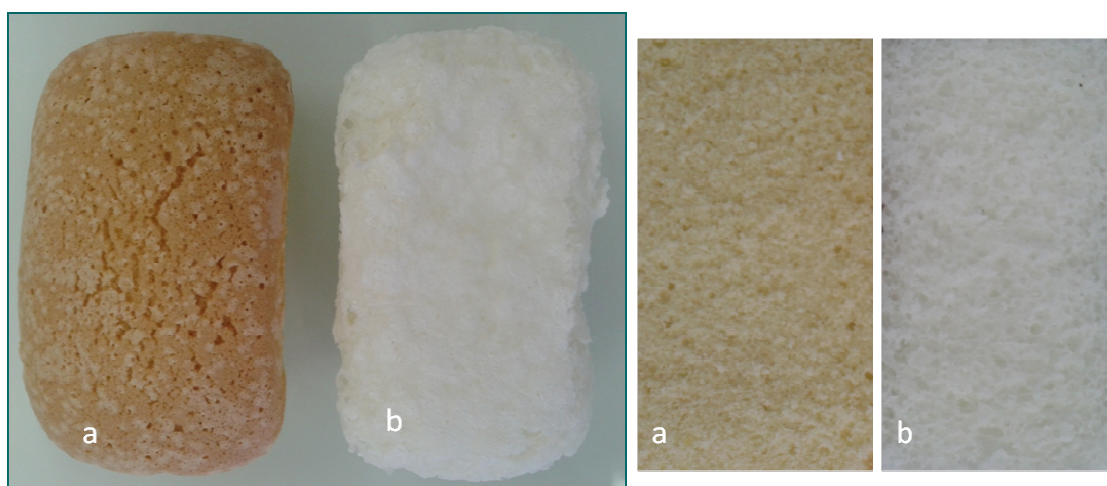


Fig 3. Reference (a) and model Methocel K4M(b) cakes and crumbs (transversal cut)

Product Innovation Process in Food Industry with Focus on the Integration between R&D and Marketing

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Food has been the biggest industrial sector in France creating a hypercompetitive market situation that triggers innovation among food companies. However food innovation suffered from high failure rate, where 2 out of 3 new products failed in the market. Previous study shows that R&D and marketing are identified as major actors managing the organization and process of innovation. Large food companies were interviewed about innovation process, including other stakeholders involved: suppliers, SME, and chef. Interview was focused on company's organization, sources of innovation, and stages and decision-making process. Standard model of innovation process and role mapping of each stakeholder involved were built to clarify the relation between this organization, the high level of failure, and the nature of innovation in food industry in order to reduce the failure rate of food innovation.

Introduction

Being the most prominent industrial sector in France, food industry plays major role in the country's economy. Food is far ahead other industrial with its total number of 59.717 enterprises¹. This hypercompetitive market situation triggers innovation to be the differentiation factor besides cost reduction. Each year numerous new food products are launched in French market, and between 2008 and 2009, 18% of the offer consisted of new products². This innovation relies heavily on line extensions that require extensive work of redefining formulations and investment on the production lines, but tangibly do not appear as innovations to consumers. On the other hand, food innovation results in many failures that withdrawal of products from the market after one year reaches up to 70%³ and 55 % of line extensions failed⁴. Previous studies had identified that process of innovation in food companies is driven by two functions, R&D and marketing, in a sequential manner with low level of cooperation and

communication between the actors. Beyond that, spending budget for R&D in food industry is relatively small compared to Marketing's with a ratio of 1:10⁵. Outsource of innovation becomes an alternative to cover this limitation, either from supplier or research partner.

Methods

Seven large companies representing different natures of food products were interviewed, according to classifications of food industry sector in France. Interviews were conducted with people in charge of Marketing, R&D, or Innovation functions in the company. Respondents also involve supplier companies: food ingredients and packaging company, representative of small and medium enterprises, and chef. Interview is addressed to highlight several main parameters as company's organization of innovation, steps and responsibilities of the process of innovation, process of decision making, and source of innovation, relationship between R&D and Marketing, and key factors for a successful innovation.

Table 1. Large food companies and actors interviewed

Company	A	B	C	D	E	F	G
Product type	Oil	Functional food	Precooked food	Bread cereal &	Cheese	Food beverages &	Snack & beverages
Respondent	R&D	President	R&D	Innovation	Innovation	R&D	R&D
Number of employees	726	-	12232 (group)	981	10600	16000	60000
Scope	National	National	National	National	Multi-national	Multi-national	Multi-national
Number of brands	5	2	16	23	30	80	22
Turnover	€732 million	€1.4 million	€265 million	€207.7 million	€2.6 billion	€75 billion	€20 billion

Organization of Innovation

Food companies nowadays consider innovation as a key element for maintaining their brands existence in the market and they are changing their practices to achieve that goal. They are making some adaptation in the company by restructuring the organization or creating new function or establishing an independent department of innovation, separated from either R&D or marketing. When one company decides to restructure and modify, the changes take place mainly as a consequence of uprising market demand on new and innovative food products or competing with competitor's product. Having provided a bigger space for innovation, they agreed that the adaptation gives positive impact especially on balancing contribution to innovate between R&D and marketing.

R&D and Marketing

Consumer driven companies elaborate the tasks of Marketing in innovation process to identify what consumer needs, bring this information to the company, synthesize the key market needs, and translate this to new product development. In this level, R&D starts its role to catch the idea proposed by marketing, and confirm if it has the right and sufficient resources to pursue a project. In rare cases there can be a reverse process where the initial idea comes from R&D. Half of them claim that R&D and Marketing have a balanced role in their innovation process, where both parties exchange and share the information together, until they come up with a common initiative. Common problem within this teamwork is the fact that they do not speak the same language and demand on one to another. Marketing holds the culture of listening to consumer's demand and meeting their expectation, meanwhile R&D is naturally having the culture of developing advance research and maximizing their potential to innovate.

Process of innovation

The entire process involves action steps on the stages of innovation with decision-making process at end of each step and supported by an innovation tool. A *swimlane* diagram is built to illustrate standard process of innovation including the decision making process in a large food company with a mature innovation system. A transversal team from multidisciplinary backgrounds is assigned for each of the selected project. Depending on the scope and size, other functions as production, purchasing, quality, supply chain, sales and finance are normally involved. Existence of innovation division reconciles the stage gate process and shifts the scope of work among the two classic actors, R&D and marketing. Besides integrating them to be able to speak the same language, they also acquire a monitoring function of the entire stages of innovation process. In the end of the process, this function acts as an evaluator as they are in charge to follow and acknowledge all innovation projects run in the company. Initial steps are running sequentially and then proceeded by parallel steps accommodating each player to cooperate and exchange massive flow of information.

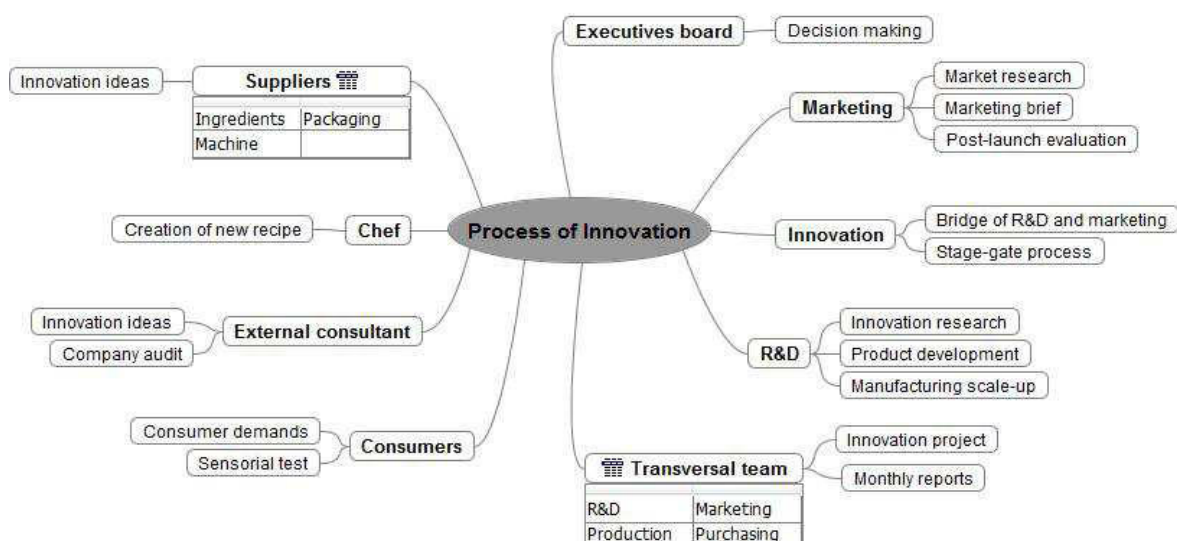
Sources of Innovation

All companies agreed that source of innovation in food industry can come from anywhere, not necessarily internal of the company. In majority of the cases, Marketing and R&D generate the idea of an innovation project, but in food company, suppliers (ingredients, packaging, and machine) become an important source of innovation. Supplier companies inevitably have the urge to innovate as how food producers are. Some other companies with limitation of capability choose to seek assistance from an external consultant. Apart from those, chef also contributes as innovation source mainly for his creativity in the creation of new recipes in the initial step of innovation process.

Role mapping of stakeholders

Diagram mapping below represents every component contributes to the process with each of their unique task.

Figure 2. Role mapping of stakeholders in innovation process in food industry



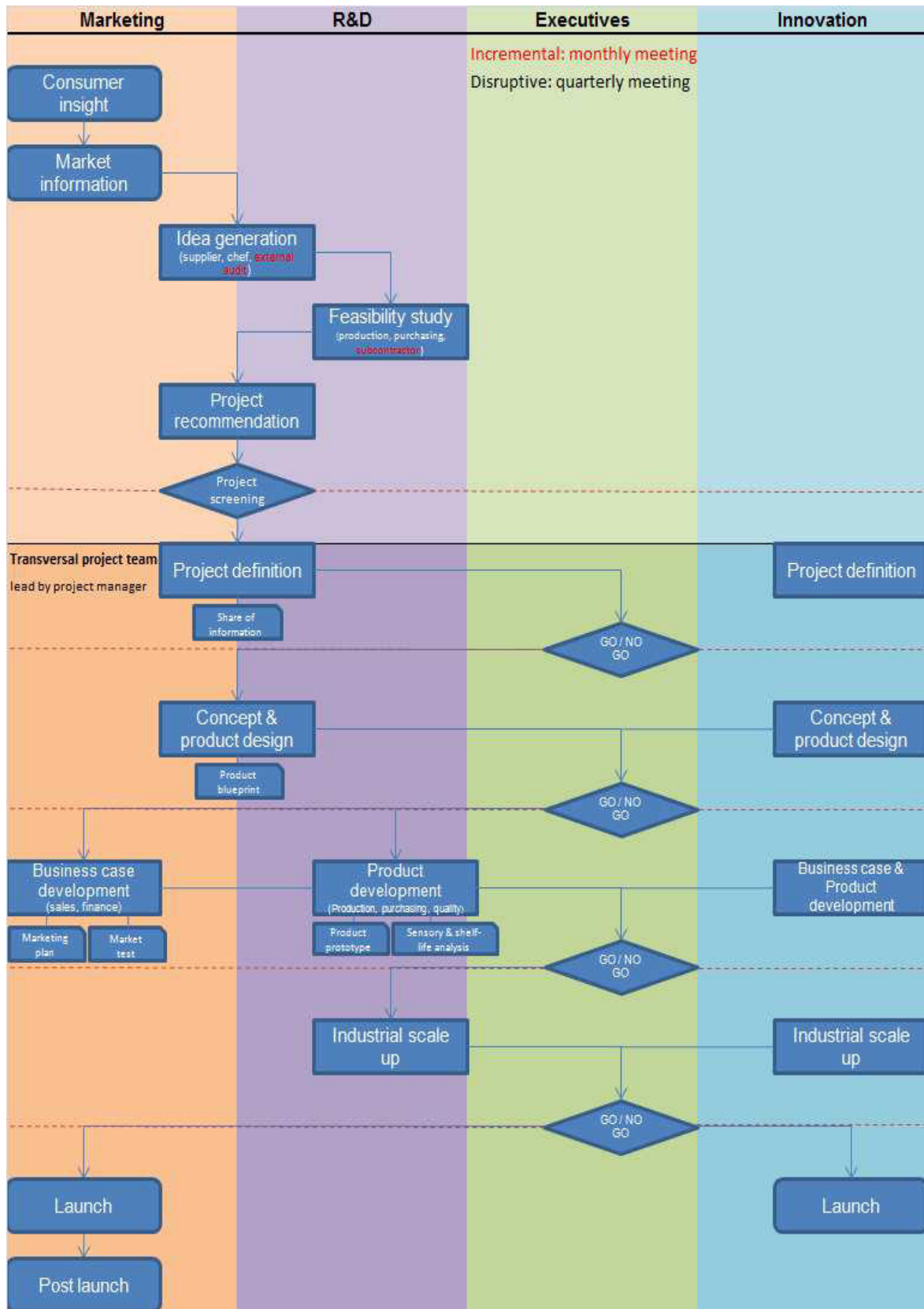


Figure 1. Swimlane diagram of proposed innovation process in food industry

Conclusion

Food companies compete to launch new product and offer new service in order to be the market leader by focusing on incremental innovation. Besides the integration of the R&D and Marketing that strongly determines the tendency of a company's innovation capacity, the newly established function of innovation is playing major act as a linking bridge to conjugate one to another. External stakeholders (suppliers, consultant, and chef) take significant part in the beginning of the process, particularly in providing input for ideas of innovation. Process of innovation in food industry theoretically runs in a sequential process but practically all actors mostly work in parallel or concurrent engineering that allows the fluidity of massive transfer of information and accommodates rapid flow of sharing and discussion.

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Design of a process for the development of functional food ingredients from fermented spirula (*arthrospira maxima*)

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Profile in a nutshell:

Undertook an undergraduate degree in Food science and post harvest technology at the Jomo kenyatta University of Agriculture (Kenya).

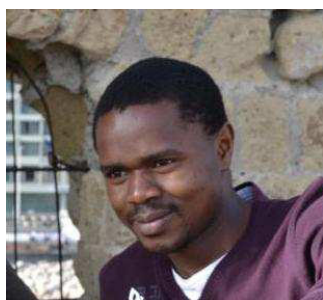
Worked as a chemist in the Quality assurance Laboratory of Nestle Kenya.

Specializes and is interested in the development of functional ingredients and development of functional foods.

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Arthrospira Maxima also commonly known as *Spirulina maxima* is a blue-green Cyanobacteria known to possess and produce a wide range of bioactive compounds with diverse biological activities ranging from antihypertensive, antioxidant, antimalarial, metal binding, antibacterial, anti-inflammatory among other beneficial effects. Most of the research works on it have been done on the entire biomass and phycocyanin extract thus leaving the contribution of other fractions or components to the functionality to remain unknown. Current methods used to obtain bioactive compounds from *Arthrospira maxima* are mainly costly, complex and only feasible at laboratory scale.

The main aim of this work was to develop a simple and economically feasible procedure for obtaining functional ingredients from different fractions of the cyanobacteria and utilizing fermentation to enhance the bioactivity. Fermentation has been reported in literature to enhance the bioactivity of various foods. *Arthrospira maxima* was subjected to different modes of fermentation then precipitated in acetone to obtain different fractions. The antioxidant, iron binding, ACE inhibitory activities and the stimulation of the growth of Lactic acid bacteria were analyzed to enable the association of the fractions with their optimum activity.

Fermentation enhanced the bioactivity of various fractions and the fractions also offered an opportunity for the production of functional ingredients with varying bioactivities.

Introduction

Arthrospira is a spiral shaped blue-green Cyanobacteria with two main species being consumed as food: *A. plantensis* and *A. maxima*. They are generally found in tropical and subtropical regions in warm water bodies with high alkalinity. Spirulina extracts are reported to have shown various biological properties due to their bioactive compounds thus presenting them as a great source of bioactive ingredients. These properties have been attributed to different compounds such as phenolics, phycobiliproteins, carotenoids, organic acids, sulphated polysaccharide spirulan and polyunsaturated fatty acids (Cohen 1997, Belay 2002)

Recently, there has been significant interest in the commercial utilization of microalgae, based on their valuable chemical constituents many of which exhibit multiple bioactivities with applications in the food, cosmetic, agriculture and horticultural sectors and in human health.

Fermentation has been reported to lead to alteration of food materials in terms of their chemical nature, sensory properties and the efficacy of their bioactive components (Shahidi 2009). It has also been reported to have the ability to impact on the activity and growth of lactic acid bacteria (Sahlin 2009).

Aims

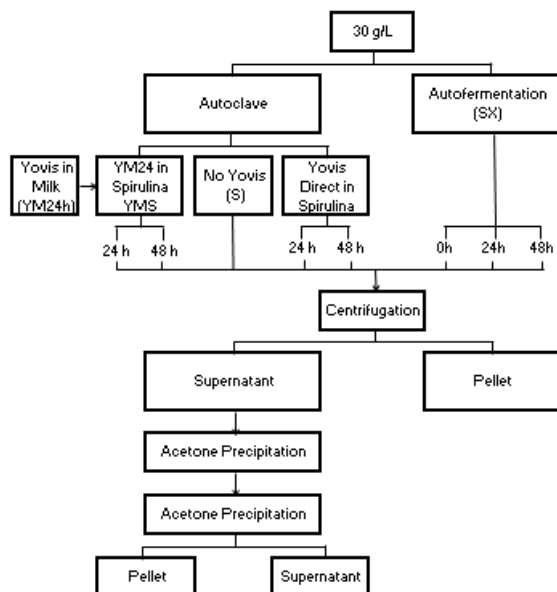
The objectives of this thesis were to develop a simple and economically feasible procedure for obtaining functional ingredients from Fermented *Arthrospira maxima*, determination of the bioactive functions of the different fractions, incorporation of benefits of fermentation to improve efficacy of bioactive compounds and determination of the activity and growth of lactic acid bacteria during fermentation of *Arthrospira maxima*.

Methods

Arthrospira maxima (30g/L) was used in the preparation of different samples. The first sets of samples were let to ferment naturally at 37°C and were referred to as auto-fermented samples (denoted SX). The second set was autoclaved and then inoculated directly with a commercial probiotic mix (Yovis®) and incubated at the same temperature as the first (denoted YS). The third was autoclaved and used as it is (denoted S) and the last set was inoculated with milk that had been fermented for 24 hours using Yovis® and was also incubated at the same temperature (denoted YMS). The fermentations were allowed to take place for 24 and 48 hours. The samples were then subjected to microbial analysis to determine effects on lactic acid bacteria and total viable count.

The fermented samples were then subjected to centrifugation at 4000 rpm for 15 minutes to obtain the supernatant which was used in subsequent steps. The supernatant at this point was referred to as a crude extract for the purposes of this work. Acetone precipitation of the supernatants was then done at a ratio of 1:4 (sample : acetone). This was further centrifuged to obtain pellets and supernatants fractions (Figure 1) which were subjected to bioactivity analysis: antioxidant, iron binding and ACE inhibitory activities.

Fig. 1. Flow chart for samples preparation.



Microbiology analysis was one by use of standard plate count method. Anaerobic and aerobic lactic acid bacteria, lactic streptococci and total viable count were grown in MRS, M17 and PCA media respectively for 48 hours at 37°C.

Antioxidant activity was analysed by ABTS method as described by Pellegrini *et al* (1999). The scavenging ability of the samples was compared with Trolox standard .

Iron binding activity was analyzed according to Harris 1996. Its a colorimetric method based on the principle that iron is reduced to form ferrous ions in the presence of hydroxylamine.

ACE inhibitory activity was done by use of HPLC-DAD based on an assay developed by Lahogue *et al* (2010). The method is based on hydrolysis of HHL by ACE to Hippuric acid. The extend of Hippuric acid released is analysed.

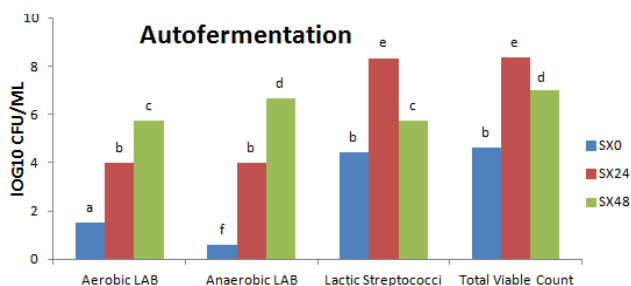
SDS-PAGE was done based on Shagger and Von Jagow(1992). Dialysis membrane (Spectra/Por Biotech Cellulose Ester (CE) MWCO: 100-500D) and Color Marker (Ultra-Low Range M.W. 1060-26600) were used.

Results and Discussion

Microbiology

The autofermented samples showed that they stimulated the growth of the Lactic acid bacteria (LAB) thus

Fig. 2: The effect of fermentation on microbial growth.



providing an opportunity for them to be utilised in the development of functional ingredients that are associated with gastro intestinal health (Fig. 2). The Yovis inoculated samples had growth but were lower in comparison to autofermentation. This may be because the autofermentation microorganisms are adapted to the *Arthrospira maxima* environment.

Antioxidant activity

The crude extract exhibited higher antioxidant activity in comparison to the others and this was attributed to the activity of various components available. However the acetone precipitated Pellet sample that had undergone direct inoculation and fermented for 48 hours was chosen as the most appropriate for an antioxidant ingredient based on its purity in comparison to the crude sample and its successive increase in activity with fermentation time. The autofermented pellet at time 0, autoclaved supernatant and the autofermented one at time 0 also showed high values thus can also be used for antioxidant functional ingredients.

Iron binding

The binding activity of pellets exhibited values more than 20% (Fig.3) while for the supernatant only the autoclaved and auto-fermented at time 0 showed values higher than 10% (Fig.4). The low iron binding values in the supernatant indicate that fermentation lowered the Iron binding effect thus may offer an opportunity for the reduction of antinutrient factors that bind to necessary minerals and trace element in the body. On the other hand, it has been reported in literature that *Arthrospira maxima* has detoxifying effect against heavy metals; the high metal binding activity of the pellets may be used for detoxification purposes in the body.

Fig. 3: Iron binding activity of pellets

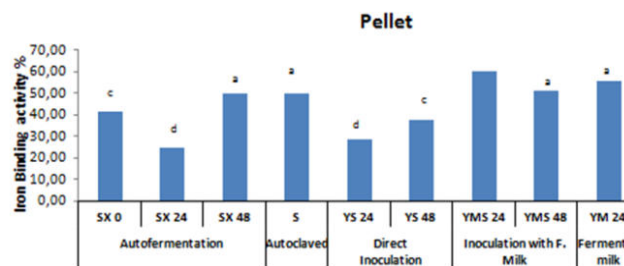
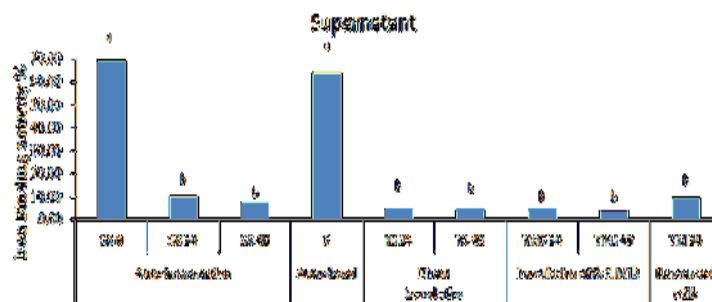


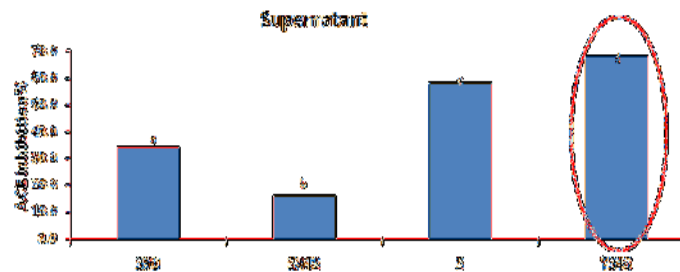
Fig. 4: Iron binding activity of supernatants.



ACE inhibitory activity

The supernatant from direct inoculation and fermented for 48 hours was presented as best candidate for the development of antihypertensive functional ingredients (Fig. 5). It was hypothesized that the large peptides are in the pellets while the small one are based in the supernatant. The fermentation time of 48

Fig. 5: ACE inhibitory activity of supernatants



hours also ensured that they are broken further to smaller peptides. This proves what has been reported in literature that the greatest activity for antihypersensitivity is due to low molecular weight peptides.

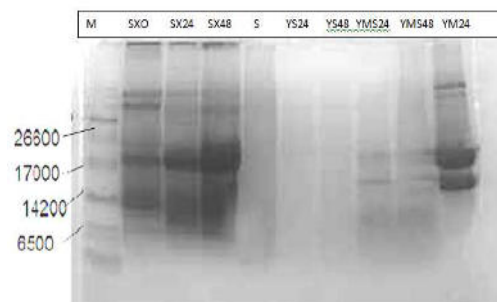
The direct inoculation sample of the pellet also showed significant increase in comparison to the autoclaved sample thus proving further that fermentation enhanced the activity.

SDS-PAGE

The results indicate two clear phycocyanin bands in the auto-fermented samples, as the fermentation time increases the bands spread towards the bottom thus indicating breakage to lower molecular weight peptides. Lower molecular weight peptides have been associated with high bioactivity.

The autoclaved sample doesn't indicate a band but has a smear, indicating that autoclaving denatured the

Fig. 6: SDS-PAGE result



proteins thus there were no definite structure that would appear as a band. However as the autoclaved sample was subjected to fermentation, the samples became clearer with time indicating there was further break downs thus enhancement of activity. The last sample is the fermented milk and its protein bands are also found to be present in the samples inoculated by it.

Conclusions

The auto-fermented samples offered the best ingredient for enhancement of the growth of lactic acid bacteria, the pellet from direct inoculation at 48 h offered a source of antioxidant ingredient, the supernatant sample that was directly inoculated was the most potential for ACE inhibitory activity and for the Iron binding results; most supernatants other than autoclaved and auto-fermented at time 0 indicated ability to lower anti-nutrient factors, the pellet samples offered an opportunity to be used as functional ingredient in the detoxification of heavy metals in the body.

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Design of new foods with Spirulina (*Arthospira maxima*) and its Phycocyanin rich extract

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Profile in a nutshell:

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Arthospira maxima is the most cultivated cyanobacteria; presenting nutritional advantages as being high in proteins, Vit. B₁₂ and for presenting important functional activities, such as antioxidant activity and anti hypertensive activity, among others. One of the most well known proteins of it is the phycocyanin by being of great interest for presenting a blue coloration. Literature reports several extraction and purification methods but only a few can be replicated in industrial scale and the cost of these technologies exceeds the opportunity benefit, therefore there is a need of the creation of a new extraction and separation method. In this work a microwave assisted extraction (with a biomass-to-solvent ratio of 20 g L⁻¹, using distilled water as a solvent, at 180 W, up to reaching 8°C and with a maceration time of 16 h at 4°C) was the proposed alternative, in combination with a double centrifugation and with a double filter pressing (250, 100 and 20 μm). Pasta was made with this extract and a second formula with fresh Spirulina (which was proved in this work no to have any difference when comparing the color results with the lyophilized one. Nevertheless both pasta formulations have an extreme color change after cooking.

Introduction

Spirulina can be considered to be an ideal candidate for its inclusion in functional foods for containing all of the essential amino acids with excellent bioavailability (Plaza et al. 2009), possessing a significant concentration of important vitamins such as B₁₂ (Becker, 2004) and for having several biological functional activities such as antioxidant, hypolipidemic, anti inflammatory activity, among others (Deng & Chow, 2010). Although, Spirulina containing products are usually manufactured using thermally dried whole cells, increasing the price of production therefore limiting their accessibility.

In Spirulina about 20% of the dry weight is phycocyanin. (Santigo-Santos et al., 2003). C-

phycocyanin has been widely studied for being a natural blue colorant for the food industry. Albeit the extraction, separation and purification processes involve several unit operations and expensive technologies, making it difficult for the widespread commercialization of a colorant from this source.

In this work the application of different processes of extraction were studied, focusing deeply on the Microwave Assisted Extraction (MAE). Two separation methods were tested in order to obtain a food grade C-phycocyanin extract

Aim

The present work had as main objectives the development of an economical and feasible process for scale up for the extraction and separation of C-phycocyanin and the design of a pasta with the addition of Spirulina and its phycocyanin rich extract; employing fresh microalgae biomass without any treatment other than pressing, assessing the impact in the final color of the product and on the biological activities.

Materials and methods

Spirulina biomass was subjected to five different extraction processes, homogenization (at 260 and 460 bar), dynamic pressure (15 cycles of static-dynamic phase, from 1 to 1.8 bar for 130 sec and 105 respectively), bed milling, freezing and thawing (3 cycles of freezing at -20°C) and Microwave Assisted Extraction (MAE) (varying wattage, biomass to solvent ratio, temperature and solvent). Separation was done with centrifugation (6.572 x g for 10 min) and using a filter press (with a triple filtration 250, 100 and 20 µm).

C-PC concentration (mg ml⁻¹), yield (mg g⁻¹) and purity ratio were measured, the concentration was calculated following the formula proposed by Yoshikawa & Belay (2008):

$$c_{PC} \left(\frac{mg}{ml} \right) = (0.162)OD_{620nm} - (0.098)OD_{280nm}$$

The purity ratio was calculated as the ratio between the absorbance value at 620nm divided by the absorbance value at 280nm.

Pasta was made at laboratory and pilot production, three formulas were made, one with fresh Spirulina (FSP for laboratory scale and IFSP for pilot production), one with lyophilized Spirulina (LSP for lab. scale, and ILSP for pilot production) and a third one with a C-PC extract obtained by MAE (PCP, and IPCP for pilot production). Pastas with spirulina were made in order to have 3% dry weight Spirulina after drying and 0.24% C-PC, pastas with C-PC extract were made in order to have 0.12% C-PC dry weight after dried.

Color was assessed with a Minolta CR-300 (Japan) colorimeter, for fresh, dry and cooked pasta. The results expressed in terms of Lab, ΔE and hue were calculated with the following equations:

$$\Delta E = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

$$h_{ab} = \arctan 2 \left(\frac{b^*}{a^*} \right) = 2 \arctan \frac{b}{\sqrt{a^2 + b^2} + a}$$

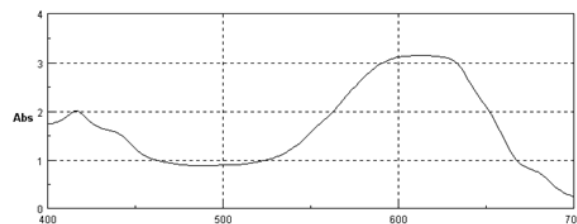
Results and Discussion

Freezing and thawing proved to have better results than the mechanical rupture of the cells made by the simulation of a bed milling using a mortar and a pestle (Graph 4). When the cell is freezing, there is an inevitable intracellular ice formation, which results in damage for the cell (Acker and McGann 2003), resulting in a better extraction of intracellular substances. Even when at high biomass-to-solvent ratios an extract with high concentration and yield can be obtained either using freezing and thawing or bed milling, both methods involve several operations and can be considered as time consuming and unfeasible for large scale production.

For the dynamic pressure method, the purity ratio was quite low (0.40) giving to the aqueous extract green appearance instead of a dark blue one. As well the purity ratio when homogenizing the biomass was not above the 0.7, nevertheless with a yield superior to 80 mg g⁻¹ was achieved in the homogenization treatment, while with dynamic pressure the yield and concentration were the highest values obtained compared to the other methods (Graph 4).

The microwave radiation breaks the cell wall matrix and leads to severing of the cell, by the evaporation of moisture present into the product the pressure increases causing also the rupture of the cell so the active constituents from the algal cell leach in the solvent leading to an increased interaction between the extracting agent (Kumar et al., 2011).

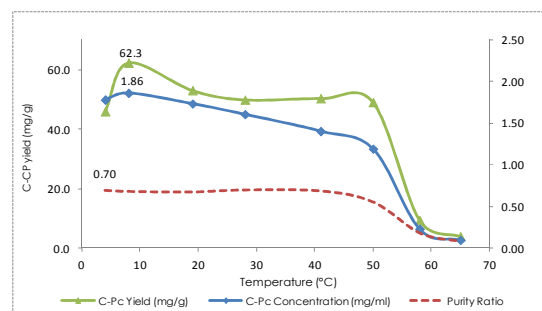
Graph 1. Spectrum wavelength of dynamic pressure extraction of C-Phycocyanin.



Considering that C-PC preparations with purity ratio greater than 0.7 are generally considered food grade (Rito-Palomares et al., 2001), analyzing the spectrum wavelengths of the three extraction methods (Dynamic pressure, homogenization and MAE), it's quite noticeable how at the wavelength of 410nm there is a peak of a certain pollutant (Graph 1), in this case it could be Chlorophyll a, which normally has an absorption peak at 430 nm, but it can shift to 410 nm (Singh & Singh, 1984), therefore turning the appearance of the extract into a dark green tonality. Having the MAE the lowest ratio of 410nm/620nm, being of 0.43 the ratio, compared to the 1.33 from the homogenization extraction it was considered the method with the best results.

The main factors affecting the extraction are biomass-to-solvent ratio, time and solvent employed. Different biomass-to-solvent ratios were tested (10, 20, 40, 60 and 80 g L⁻¹), it was proved to have a significant impact on the purity ratio, although not as significant as for the yield or concentration. The highest purity (of 0.71) was achieved at a concentration of 20 g L⁻¹.

Graph 2. Concentration, yield and purity ratio of C-PC extracted by freezing and MEA with distilled water at different temperatures (20 g L⁻¹ concentration, 180 W, 16 h at 4°C maceration)

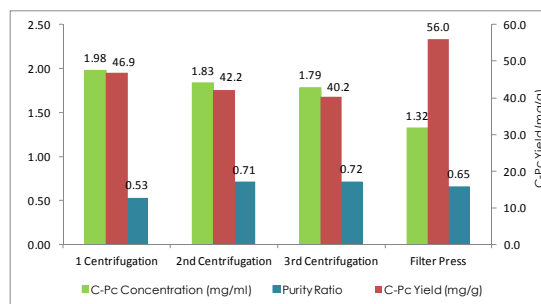


Different wattages were tested, 100, 180, 300 and 450W. The concentration was the parameter that was most largely affected, once again being at 180W the treatment with the highest value, being almost 20% on top of the average. Purity and yield remained practically the same regardless of the wattage employed. Extended reaction times provide for enhanced exposure of microwaves to the reaction mixture which result in better yields of extraction (Patil et al., 2012). The time of exposure to the microwaves is determined by the temperature to reach. The extract purity was almost constant at low temperatures, it is favored when using low temperatures, the purity of the extract is significantly influenced by temperature (Graph 2); high temperature result in reduced purity because it facilitates the extraction of other proteins. The results show that the best temperature for the microwave extraction is around 8°C, having the highest purity, yield and C-pc concentration. After reaching a temperature of 50°C all parameters (yield,

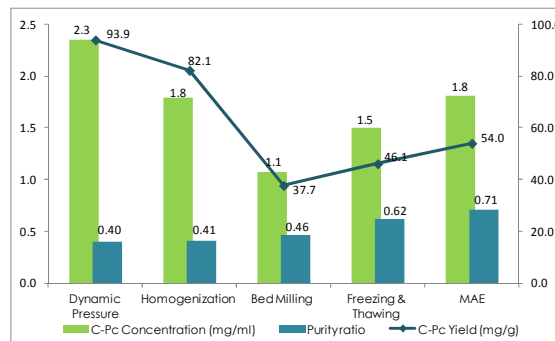
concentration and purity) decrease drastically, since at 47°C is the critical temperature for stability of phycocyanin solution (Chaiklahan 2011).

The separation was done by repeated centrifugation and by filter pressing. By centrifugation the purity ratio increase considerably by centrifuging the solution twice (Graph 3) going over 0.7 being able to be used for food. With the filter pressing, the separation time was reduced significantly and the yield increased up to achieving 56 mg g⁻¹. The purity ratio is higher than the value for the first centrifugation, although smaller than those of the 2nd and 3rd. As well the concentration is smaller than the centrifuged treated samples. Proving that by filtration a good yield can be achieved with a slightly lower concentration and a purity ratio almost of 0.7. Filtration can be a feasible option since the time is reduced considerably from the centrifugation treatment.

Graph 3. Concentration, yield and purity ratio of C-PC extracted by freezing and MEA with distilled water after 1, 2 and 3 centrifugations (20 g L⁻¹ concentration, 180 W, 16 h at 4°C maceration)



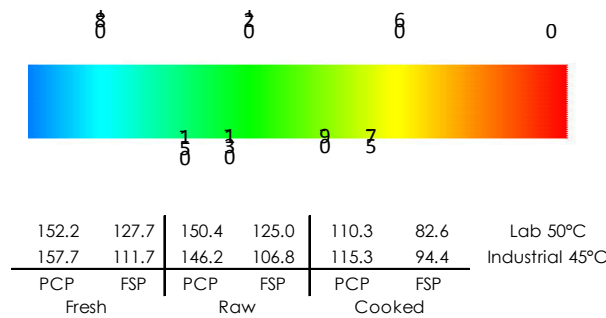
Graph 4. Concentration, yield and purity ratio of C-PC extracted by different method (20 g L⁻¹ concentration, 16 h at 4°C maceration)



Pastas at laboratory scale were done at 3 different temperatures, 50,70 and 100°C, until reaching the final water content of 11%±1. The main objective of the experiment was to asses if there was a visual difference between pasta with Spirulina applied lyophilized versus fresh employment both when dried and cooked. The addition of Spirulina either fresh or lyophilized resulted in products with negative a* and positive b*, leading to green hues (h^ab = 122.0 – 129.3) before cooking, which present a significant change when cooked, moving up to values of hue from 77.4 – 92.1. The hue difference in raw pastas between lyophilized and fresh spirulina usage is of 6° on average, while cooked is of approximately 8°, always the lyophilized presenting higher values. The ΔE*_{ab} between fresh and lyophilized (either cooked or dry) show that there's always a difference bigger than 3, which is appreciable (detectable by ordinary people).

Concerning the C-PC extract in pasta, the color resulting had a hue of 150.4 which barely touches the blue region of the spectrum. Since the flour used (semolina) has a yellow color the mixture of this and blue led to a green coloration. A experiment was done in granite flour (white color flour) and the value of b* was of -4, entering the blue range, although after cooking it went up to values around +8, losing the blue coloration, the hue value when fresh (it wasn't submitted to drying) was of 164 while cooked drop up to 130.

Table 1. h°_{ab} of raw and cooked pasta samples (FSP and LSP) at lab scale dried at different temperatures.



The pasta made at pilot level was done at 45°C drying temperature. The values were similar to the ones obtain at the drying at laboratory scale done at 50°C, although the loss of color after cooking diminish a little bit in the one made at pilot scale. (Table 1).

Figure 1. Pasta at industrial scale (Up left – IFSP raw dry, up right – IFSP cooked, down left – IPCP raw dry, down right – IPCP cooked)



The ΔE^*_{ab} between comparing them raw and after cooking was of 14.2 for the pasta made with fresh spirulina and of 18.7 for the one made with the phycocyanin extract; both values are consider to be extreme, belonging to another color group.

Conclusion

Microwave assisted extraction proved to have the best purity ratio results. Although a higher concentration and yield could be obtained by other methods the extract appearance was highly contaminated with other particles which avoided the extract to appear blue. The separation of the C-phycocyanin can be made by a filter press or centrifugation, the latest obtaining better purity results but considerably taking more time.

The use of the fresh untreated microalgae biomass was proved to be a practicable solution for the production of enriched pasta with Spirulina, resulting in an attractive color product (being not different after drying from the pasta made with lyophilized biomass). The addition of the C-phycocyanin extract into a pasta led to a product with attractive appeal, although not being with a blue coloration (for the interaction of the color matrix and the colorant).

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Olive oil phenols and whey proteins : binding properties and their impact on final antioxidant activity

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Profile in a nutshell:

Bachelor degree in Nutrition Science, have worked within the Health and Public Health spheres. After working as junior researcher on food bioactive properties, my interest was directed to Food Science and Technology, which motivated me to pursue my "Food Innovation and Product Design" Master Degree.

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Virgin olive oil is a central ingredient in Mediterranean diet and its phenolic compounds are strongly related to the health benefits that have been attributed to virgin olive oil consumption. Binding interactions between proteins and phenolic compounds, however, might take place during preparation of foods and impact on the final antioxidant activity or reduce the bioactive properties of phenolic compounds, as well as reduce protein bioavailability. Literature reports some protein binding properties of phenolic compounds, mainly catechins and phenolic acids from tea, coffee, fruits and vegetables. The aim of this work was to assess the interactions between virgin olive oil polyphenols and whey proteins on a model system and on a mixture of ricotta "cheese" and virgin olive oil, following the traditional Mediterranean practice of mixing milk products (mozzarella, ricotta, feta, other cheeses) and virgin olive oil. Covalent bonds were evaluated by HPLC and MALDI-TOF-MS. The impact of the complex on antioxidant activity was also evaluated by ABTS method. Furthermore, the impact on pungency perception once olive oil is mixed with ricotta was assessed by means of a naive sensory panel.

Introduction

Mediterranean countries have their individual dietary traditions; however, all of them have common points such as the central position of olive oil on the diet. From a health point of view, phenolic compounds in virgin olive oil (VOO) are important constituents as they are related to antioxidant and anti-aging activities and the protective against coronary diseases, chemo preventive and anticancer effects attributed to VOO consumption (López-Miranda *et al.*, 2010; Trichopoulou *et al.*, 2000). Traditionally, virgin olive oil is combined with protein-rich ingredients in the Mediterranean culinary, as meat, fish and dairy products like mozzarella and ricotta. This last one is the dairy product obtained from whey protein thermic/acid

precipitation; it is an unripened, soft and creamy product with mild flavor (Di Piero *et al.*, 2011) largely consumed specially in Italy.

The practice of combining bitter, pungent and astringent products with milk proteins has been explained by the polyphenol – bitter compounds – binding property to proteins. Several Authors have demonstrated this property especially regarding epigallocatechin gallate (EGCG) and phenolic acids as chlorogenic acid (5CQA), which are polyphenols largely distributed in herbs, vegetables and fruits (Papadopoulou and Frazier, 2004). On the other hand, VOO is composed of different phenolic compounds, mainly secoiridoid derivatives, including the aldehydic or dialdehydic forms of elenolic acid (EA, EDA) linked to a phenolic alcohol like hydroxytyrosol (OHTy) or Tyrosol (Ty). Binding affinity between phenols and proteins is related to protein thiol group, and increases proportionally to the polyphenol molecular size and the number of hydroxyl groups (Hasni *et al.*, 2011).

Aims

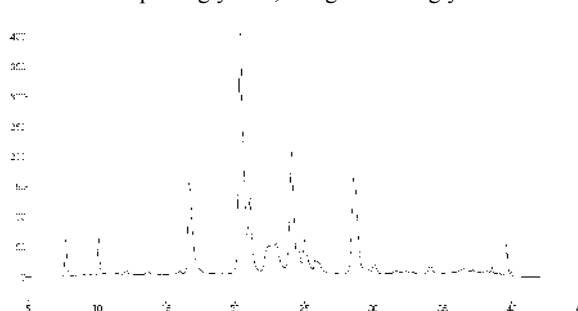
The present work had as main objectives the assessment of virgin olive oil polyphenols binding activity to whey proteins, as a model of ricotta and extra virgin olive oil preparation, and the evaluation of the impact of the interactions on the final antioxidant activity. In addition, the impact of protein binding on extra virgin olive oil bitterness and pungency was assessed.

Methods

A simplified ricotta model was adopted using b-lactoglobulin (BLG) standard in ammonium acetate buffer pH=6.

Phenolic standards (EGCG, 5CQA, OHTy or Ty) or an extra virgin olive oil phenolic extract (EVOO-PE) were added into BLG solution and incubated for 24h at room temperature. Final incubation concentrations were: protein 83mM and polyphenols 166mM or 250mM. HPLC phenolic profile of the used (EVOO-PE) is presented in **Figure 1**.

Figure 1. EVOO phenolic extract (EVOO-PE) characterization by HPLC. Labels: 1- hydroxytyrosol; 2 - tyrosol; 3- dialdehydic form of elenolic acid linked to hydroxytyrosol; 4- dialdehydic form of elenolic acid linked to tyrosol; 5- 1-cetoxypinoresinol and pinoresinol (lignans); 6- oleuropein aglycone, 7- ligstroside aglycone.



After the equilibration period, a separation step by HPLC took place and collected peaks were further analyzed by matrix assisted laser ionization/desorption mass spectrometry coupled to a time-of-flight detector (MALDI-TOF-MS).

Antioxidant activity was evaluated by the ABTS method, according to Re *et al.* (1999) with modifications, in order to assess the antioxidant activity inhibition by protein interaction.

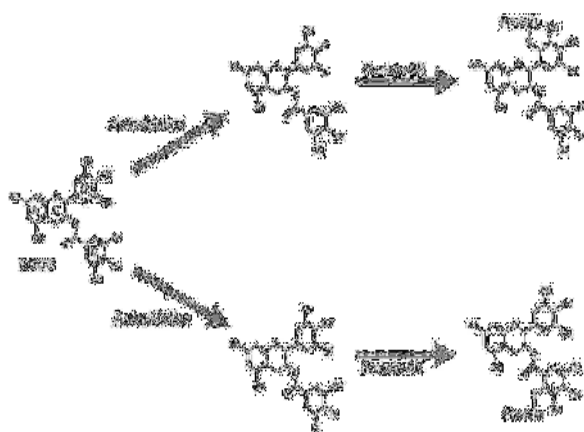
Finally, a preliminary sensory analysis test was conducted with a naive panel (n=20, 10 female and 10 male) with the aim of assessing extra virgin olive oil pungency and bitterness perception modulation by ricotta cheese mixing. Panelists were asked to identify differences on pungency and bitterness perception between two samples: sample 1 was constituted of EVOO diluted (1:1) into retified olive oil, and sample 2 was constituted of the same EVOO mixed with ricotta in the same proportion. Data analysis were performed on GrapPad Prisma Software v.6.

Results and Discussion

Several studies have reported binding affinity of EGCG and 5CQA to milk proteins (Papadopoulou and Frazier, 2004) and the likely mechanism of interaction involves the autoxidized polyphenols and a free thiol group on the protein structure (**Figure 2**).

Source: Ishii et al., 2008

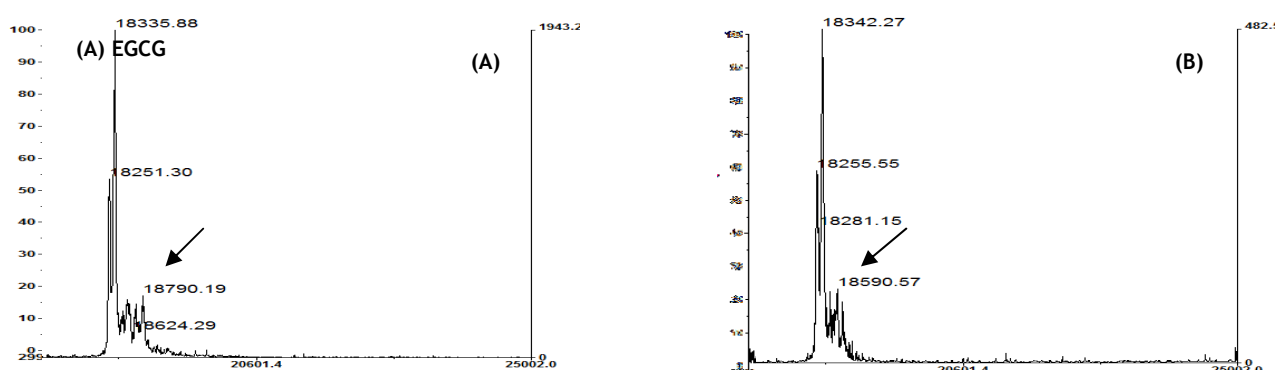
Figure 2. Proposed mechanism for EGCG binding to a protein cysteinyl thiol group through autoxidation.



In our experiment, EGCG and 5CQA, as expected, exerted covalent bonds to BLG as observed by the shift on BLG (variants A and B) molecular weight corresponding to the linkage with the phenolic molecules (**Figure 3**). On the other hand, no covalent bonds were observed for OHTy and Ty standards.

According to Pripp et al. (2005), VOO phenolic alcohols (OHTY and Ty) are relatively small molecules that do not, or very weakly, exert non-covalent bonds. In the same study, non-covalent binding between VOO secoiridoids were identified, being the dialdehydic forms of elenolic acid linked to OHTY or Ty (Ohty-EDA, Ty-EDA) the compounds with higher binding strength.

Figure 3. MALDI-TOF mass spectra. (A) EGCG and (B) 5CQA. Highlighted peaks represent BLG linked to the respective phenol by means of covalent binding.



The incubation of EVOO-PE with BLG resulted on a shift on the protein molecular weight in correspondence to the interaction with secoiridoid derivatives (**Figure 4**). Even though, as already discussed, secoiridoid non-covalent binding to proteins have been reported in literature, to our knowledge, this is the first time covalent bonds are observed between bovine BLG and VOO secoiridoid derivatives.

All polyphenols had their antioxidant activity, assessed by ABTS method, inhibited by the incubation with BLG; being OHTy the most affected compound (56% of inhibition), followed by the EVOO-PE, 5-CQA, Ty and EGCG, with % of inhibition of 42.84, 23.19, 17.96, 6.38% respectively (**Figure 5**).

The reduced inhibition percentage to EGCG and 5CQA illustrates once again the role of specific hydroxyl groups on the covalent binding process, remaining still free hydroxyls, able to scavenge ABTS radical.

The same effect regarding EGCG and BLG was observed by other Authors using the same antioxidant activity evaluation method (Almajano *et al.*, 2007; Stojadinovic *et al.*, 2013).

Figure 4. MALDI-TOF mass spectra. BLG incubated with VOO phenolic extract. BLG B (b-lactoglobulin variant B). BLG A (b-lactoglobulin variant A). EA – elenolic acid. Sec. der. – secoiridoid derivatives.

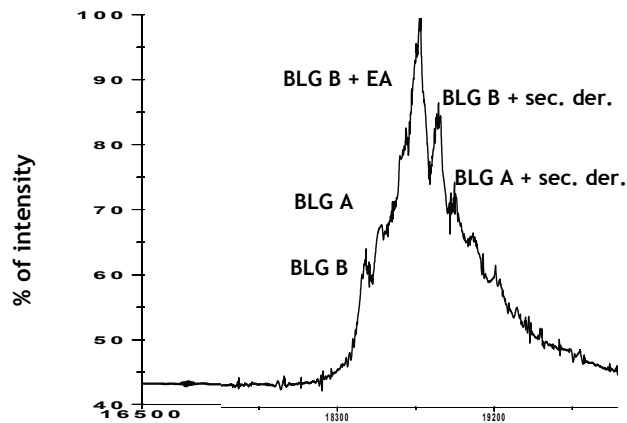
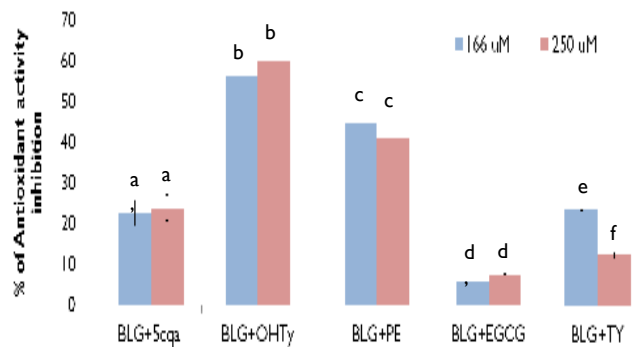


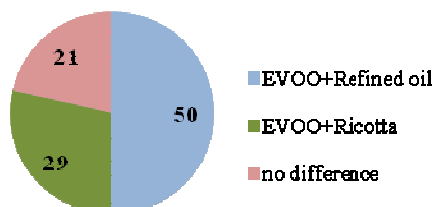
Figure 5. Antioxidant activity inhibition (%). It was considered as 100% the antioxidant activity values of individual molecules (5CQA, OHTy, EVOO-PE, EGCG and Ty) summed to BLG control value. Different letters means statistically significant differences ($p < 0,05$).



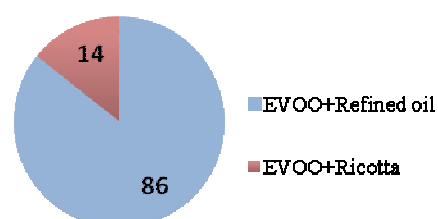
Results from sensory analysis are shown in **Figure 6**. The dilution of EVOO in ricotta showed a trend of bitterness and pungency reduction. For pungency perception this trend is more pronounced. Covalent bonds between secoiridoid derivatives may explain the reduction on pungency and bitterness perception. It is important to highlight that the two confronted samples presented different overall fatty acid profile, and ricotta also represents an aqueous matrix, these facts might interfere on final bitterness and pungency perception. Hereby, further sensory studies are in progress; confronting a) EVOO mixed with ricotta, b) refined olive oil mixed with ricotta and c) emulsion of EVOO in water and surfactants.

Figure 6. Percentage of panelists highlighting “the more bitter sample”. No difference means that no difference between the samples, regarding bitterness, was detected by the panelists.

(A) Bitterness perception



(B) Pungency perception



Conclusions

Covalent bonds between VOO secoiridoid derivatives and BLG were observed by MALDI-TOF-MS. To our knowledge, this is the first time this kind of interaction is observed between olive oil polyphenols and milk proteins.

The covalent bonds might impact on final complex bioactive activities, as the antioxidant potential. It was illustrated by the reduction on the antioxidant activity of all tested polyphenols, being OHTy the most affected by the BLG incubation. However, further studies regarding the *in vivo* impact of the binding properties must be conducted, taking into consideration the digestive environment; pH, enzymatic attack and other molecular interactions.

OHTy and Ty do not exert covalent bonds to BLG, in accordance to other studies; these molecules possess single aromatic ring and small number of hydroxyl groups, which do not characterize strong binding potential.

Mechanisms for the OHTy and Ty antioxidant activity inhibition remains unclear, since no covalent bonds were observed by the present work and literature does not report non-covalent bonds as well.

From the Food Innovation and Product Design point of view, present results may be of interest for the Food Industry once it “opens doors” to new perspectives of ingredients and functional food development. Furthermore, stability and solubility insights for these bioactive compounds can “pop up” on Research and Development teams.

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Gustatory and olfactory perception in different BMI subjects

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The objectives of this study were to investigate the preferences of gustatory and olfactory responsiveness through food preference using Pref-Quest and through sensory analysis combined with gas chromatography-olfactometry (GC-O) between normal weight and obese subjects. PrefQuest shows trend that obese group have higher liking preference towards fatty-salty food. It also been investigated further that obese and normal weight group were differ in sensory responsiveness where obese subjects tends to be significantly ($p > 0.05$) less-stimulated and less responsiveness that showed by higher detection and recognition threshold of basic tastants (sweet, bitter, salt, sour, trigeminal/sweet alcohol and astringency) compare to the normal group. Olfactory responsiveness also showed an inline result where they perceive food-based odorants intensity as significance lower ($p < 0.01$) than normal group and it showed that they have difficulties to detect and perceived some of odorants.

Introduction

Obesity has become the leading metabolic disease in the world. The WHO estimated more than one billion people are overweight and 300 million of them classified as obese. Obesity are the fifth leading risk for global death and around 2.8 million adults die each year as a result of being overweight or obese. More importantly, obesity is a risk for many other non-communicable diseases. Obesity tends to be a major cost of health care (Seidell, 2003) and has been concluded to become major contributors of total healthcare cost.

The etiology of obesity is really complex and it caused by multiply factors that involved in a complex system. Motivation to eat not only based on homeostatic body regulation but also driven by hedonic value of foods called palatability where food can tempt sensory pleasantness



(Mela, 2006). Hedonic factor from sensory aspect such as smell and taste of the foods are evolved in food procurement system and can determine food intake (Knecht, Ellger and Levine, 2008). Where recent findings had been reported that obese people have different responsiveness towards sensory cues (Berthoud and Zheng, 2012). There is an importance correlation between satisfaction of sensory appreciation, where between obese and normal weight people have different food reward mechanism towards sensory appreciation (Berridge and Robinson, 2003). Perceived taste and odor are two properties that most commonly involved in food procurement system and determine food choice both of these senses can be potentially manipulated by alterations in sensory perception (Berthoud, 2011). However, the cause-effect relationship between sensory and obesity is far from clear. Many studies have been conducted to observe the relationship between obesity and sensory perception and taste responsiveness including olfactory sensory. Nevertheless, the results still remain unclear and blunt. From this point it is really interesting to investigate the shifting alteration of sensory responsiveness in obese people through gustatory and olfactory evaluations to observe and evaluate if sensory senses in obese people have developed an alteration.

Objectives

The objective of this study is to investigate the sensory preference between obese and normal weight subjects towards gustatory and olfactory senses that were measured firstly through food liking preference and quantity-based preference focusing on salt-, sweet- and fat- sensation that measured using PrefQuest. Second, to evaluate the gustatory perception through sensory detection and recognition threshold using four basic taste solutions of sweet, bitter, salty, sour, including sweet/trigeminal sensation of ethanol and astringency sensations and to evaluate the olfactory perception using Gas Chromatography-Olfactometry (GC-O) through detection frequency methods and measuring its intensity towards specific odorants.

Methodologies

PrefQuest questionnaire was used to evaluate food liking preference focusing on salt-, sweet- and fat-liking preference. This questionnaire had been developed by Deglaire *et al.* (2012) in Centre des Sciences du Goût et de l'Alimentation (CSGA), Dijon, France as a standardized questionnaire to measure hedonic liking towards salty, sweet and fatty sensation. It had been reported that PrefQuest were feasible, well-perceived and have been evaluated through population-based-survey in France.

Sensory detection and recognition threshold were applied to evaluate gustatory responsiveness towards four basic tastes of sweet (glucose, fructose, sucrose), bitter (caffeine), salty (sodium chloride), sour (citric acid), including sweet/trigeminal sensation (ethanol), and astringency/trigeminal sensation (tannic acid). Five level different concentrations of tastants were prepared with staircase down-to-top sensory detection and recognition threshold were applied in this evaluation. Food-based odorants were used in the evaluations of olfactory responsiveness using GC-O as method tools and human olfaction system as the only detector to detect the odorants, three scale level of intensity were applied (weak, medium, strong) with all the citation and description of odorants that described by the subjects during evaluation were recorded.

Results and Discussion

There were no significant difference ($p > 0.05$) towards food liking preference between obese and normal weight people towards salt-, sweet-, and fat- liking preference sensation. But there were the trends that construct and showed the tendency for obese subjects to prefer salty and fatty-salty dishes than normal weight subjects. The quantity-based liking preference towards salt-, sweet- and fat-taste also shows the same trends. Moreover, it also shows that obese people prefer to drinks carbonated soft drinks (70%) as the first choice while normal subject prefer to drinks mineral water (70%) for their drinking preference.

Table 1. Detection and recognition threshold between different BMI subjects

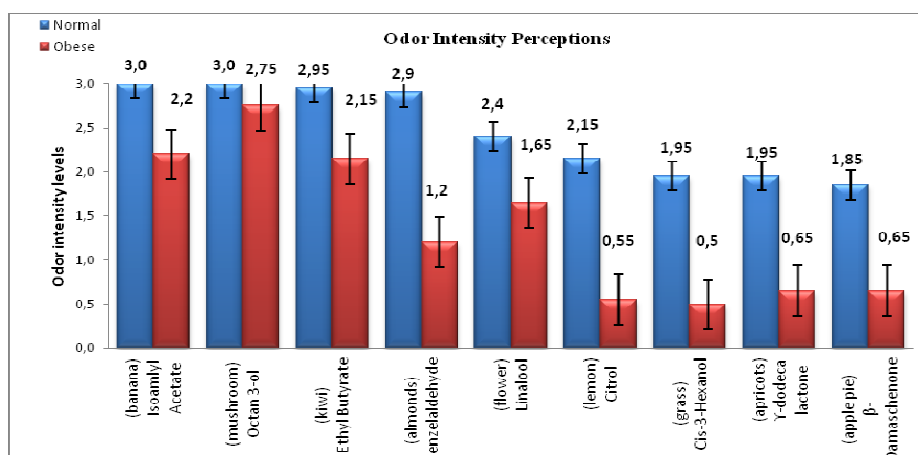
Tastant	Taste	Detection Threshold		Recognition Threshold	
		Normal	Obese	Normal	Obese
Glucose	Sweet	1,5 ± 0,50	3,3 ± 0,46**	2,1 ± 0,70	4,0 ± 0,77**
Fructose	Sweet	2,3 ± 0,64	2,7 ± 0,64	2,6 ± 0,49	3,9 ± 0,54**
Sucrose	Sweet	1,3 ± 0,46	2,5 ± 0,81**	1,8 ± 0,40	3,3 ± 0,90**
Ethanol	Sweet/trigeminal sensation	1,3 ± 0,46	2,0 ± 1,10	1,7 ± 0,78	3,4 ± 1,02**
Caffeine	Bitter	1,0 ± 0,00	2,1 ± 0,70**	1,4 ± 0,49	2,9 ± 1,04**
Sodium chloride	Salty	1,1 ± 0,30	1,7 ± 0,78	1,4 ± 0,49	2,4 ± 1,02*
Citric acid	Sour	1,8 ± 0,60	2,5 ± 0,81	2,1 ± 0,30	3,6 ± 0,80**
Tannic acid	Astringency/trigeminal sensation	1,4 ± 0,49	2,8 ± 1,17**	1,8 ± 0,60	3,8 ± 0,87**

Note: *significant difference at $p < 0,05$

**Significant difference at $p < 0,01$

The continuous investigations towards gustatory and olfactory responsiveness were measured. The results demonstrated that it show significant difference ($p < 0.05$) for sweet (glucose, sucrose), bitter (caffeine), and astringency/trigeminal sensation (tannic acid) but did not shows significant difference ($p > 0.05$) for sweet (fructose), sweet/trigeminal (ethanol) salty (sodium chloride) and sour (citric acid) however, it did shows strongly significant differences ($p < 0.01$) of recognition threshold for almost all the tastants (Table 1). It shows that obese subjects have higher detection and recognition level of tastants compare to normal weight subjects. It means for obese people they need a higher amount of concentration in order to detect and recognize basic taste stimuli. The results also shows even though

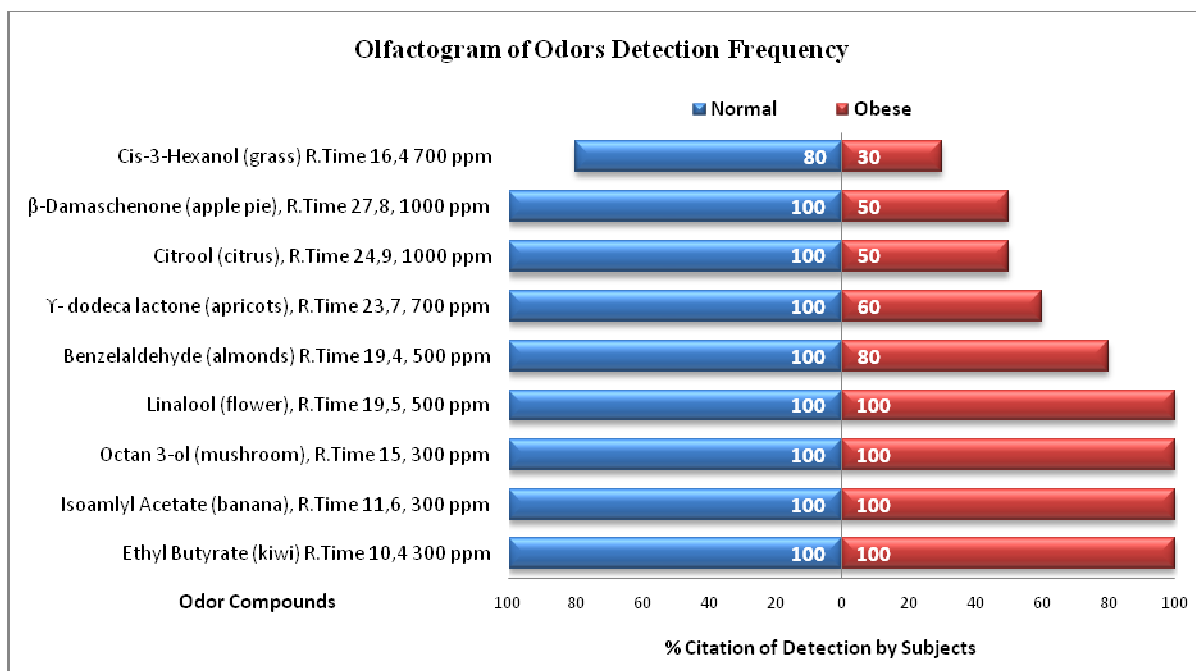
Figure 1. Odor intensity perception between normal and obese subjects



obese subjects in some tastants have the same level to detect the taste stimuli with normal weight people but the level at where they start to recognize and identified the taste stimuli is significantly different.

The Olfactory evaluations demonstrated strongly significances ($p < 0.01$) towards all odorants for detection intensity (Figure 1) except for octen-3-ol/mushroom ($p > 0.05$) where obese subjects shows to have a significantly lower intensity perception towards tested-odorants compare to normal-weight subjects. It means normal weight people have significantly higher sensitivity towards odorants where obese subjects demonstrated to have less sensitivity. Moreover, obese subjects shows difficulties to interpret and describes the odorants, they also have difficulties in perceived the sensation of odorants. Normal weight subjects can detect and perceived almost all the odorants (100%) except for cis-3-hexanol (grassy odors), but for obese people they not only shows lower tendency in perceived odor intensity but also have difficulties in perceived odors, to interpret and to describes those odorants where its shows by a lower citation for obese subjects in Olfactogram (Figure 2).

Figure 2. Olfactogram of odor detection frequency between normal and obese subjects



Conclusions and Recommendations

Based on the results even though it did not shows significant differences against food liking preference but it demonstrated a strongly differences towards sensory sensitivities focusing on gustatory responsiveness and through olfactory sensitivity. Moreover, it constructed from the results that obese subjects have tendencies to prefer salty and fatty-salty dishes more than normal weight subjects. This concluded that obese subject differ in gustatory and olfactory responsiveness than normal weight subjects where they have a lower sensitivity to perceived tastants and odorants. They are less-stimulated and less responsiveness towards sensory stimuli. This is might be one of the reasons why obese people tends to eat more than normal weight people because the level where they perceived the quantity level of sensory stimulus is different and it makes them tends to have lower stimulated than normal subjects. It also not only affected the intensity of the sensory stimulation but also affect the quality of the taste that their perceived. Moreover lower perception of taste and odor contributed to longer episodes of meals and contributed to lower satisfaction and satiation level and caused overeating and obesity, if this condition continue it caused a development and maintenance of obesity.

A higher number of subjects for the future research highly recommended to understanding better the relation between olfactory and gustatory preference in obese subjects and in partition to evaluated food preference between obese and normal weight people. The knowledge about preference alteration in gustatory and olfactory system in obese subjects could lead to useful insight for weight management and future treatment of obesity.

Acknowledgements

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Gut-brain biomarkers of food palatability: a study on bitter and sweet tastes

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The effect of gustatory system on satiety and food reward is very complex and has not been completely clarified in humans. Therefore, the main objective of this study was to find gastrointestinal and brain biomarkers of food palatability in humans. To this purpose, the response of GI hormones and of endocannabinoids to gustatory stimulation with foods having different taste and palatability was evaluated in parallel to the effects on appetite cues, energy intakes and food reward.

Introduction

Obesity is a well-known serious health condition reaching pandemic proportions (1). Since it is a risk factor of several health issues, nutritional studies aiming to point out strategies to control food intake and reduce obesity raised a lot in the last 20-year literature (2).

The control of appetite is based on a network of interactions forming part of a psychobiological system and gut-brain axis is known to play a crucial role on it (3). However, human studies of the relevance of peripheral signals and the gut/brain axis on the regulation of appetite are limited, and much of the scientific evidence come from animal studies (4). Therefore, in order to develop new foods, there is a need to understand the mechanisms underlying food intake and to individuate targets (biomarkers) of action of new foods/ingredients in vivo in humans. Furthermore, to have a long-term effect on weight management, satiating foods must also be palatable (5). Indeed, food products must meet consumers' needs and the goal involves creating tasty foods that somehow reduce overeating (6).

In this frame, stand out the need and opportunity to develop foods able to increase satiety preserving their palatability.

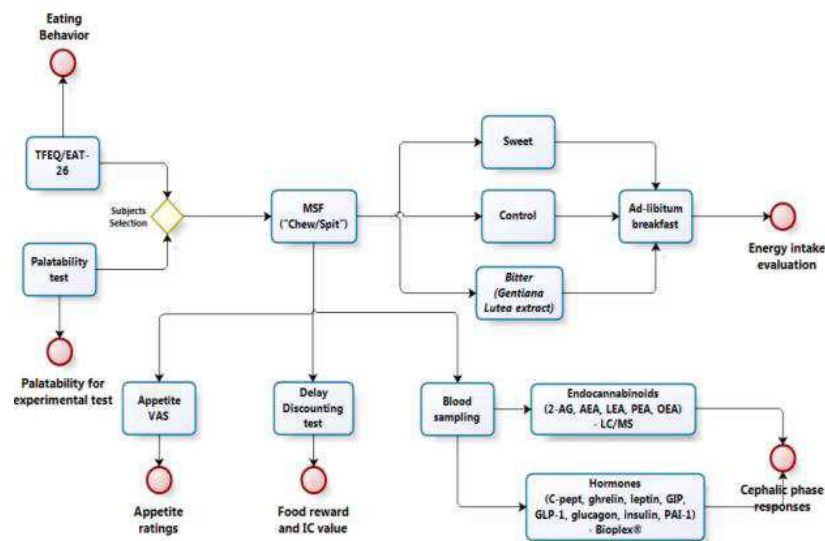
Aims

This experimental thesis aims to clarify mechanisms underlying oral nutrient sensing and to identify targets for developing new foods that may reduce food intake preserving palatability. II

Materials and methods

In order to establish the role of palatability on the cephalic phase of eating, a modified sham-feeding (MSF) protocol was developed. The study design and specific outcomes were schematized in Fig 01.

Fig. 01. Study design & Outcomes



Three puddings having the same structure but different tastes (sweet, bitter and no taste) were developed and produced.

Fifteen participants were recruited and 10 subjects (6M/4F), with mean age of 28.4 ± 3.6 y, and BMI of 24.1 ± 2.3 kg/m² successfully completed the protocol. Eating behavior was assessed by TFEQ (F1 7.90 ± 2.28 ; F2 7.00 ± 4.50). Over the selection phase of the subjects, a palatability test was carried out and subjects who liked sweet pudding and disliked bitter one compared to the control were selected.

All experimental measurements took place early in the morning with fasting subjects. Once arrived to the laboratory, subjects rated their hunger, fullness, satiety and thirst on VAS and were submitted to a first blood drawing (baseline). After 5 min, subjects started MSF (3') with one of the milk puddings (test foods) – control, sweet or bitter. Blood samples were taken at 5, 10, 15 and 20 min after the MSF. Food reward was measured by computerized Temporal Discounting task (DDT) 20 min after the last blood sampling. Subsequently, energy intake was assessed by test meal (*ad libitum* breakfast).

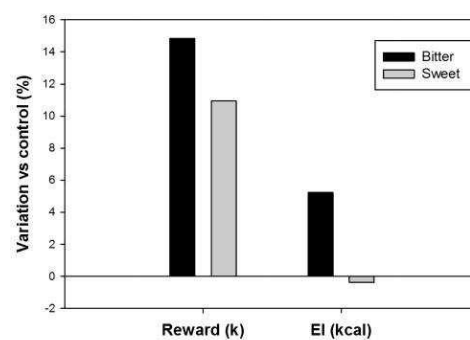
Hormones (C-peptide, ghrelin, leptin, GIP, GLP-1, glucagon, insulin and PAI-) levels were measured by a multiplexed assay using Luminex Technology (7) and endocannabinoids (AEA, LEA, OEA, PEA and 2-AG) by LC/MS/MS (8).

Statistical analysis (ANOVA, Pearson's correlation) were performed using Sigmaplot® (v. 12.5). Significance was set at $p < 0.05$.

Results and discussion

Altering the sensory properties of foods can affect individual food intake and appetite in the short-term. In this study, a trend for higher fullness and satiety as well as lower desire to eat (-2.5%) after stimulation with the palatable (sweet) pudding compared to control was found. On the other hand, a trend to increased energy intake after the less palatable stimulus (bitter) was observed. This went along with a higher desire to eat (+5.0%) and a higher temporal discounting parameter (k) (Fig. 02).

Fig. 02. Variations in comparison to control (%) of temporal discounting parameter (Reward, k) and of total energy intake (EI) at *ad libitum* breakfast following sweet or bitter puddings.

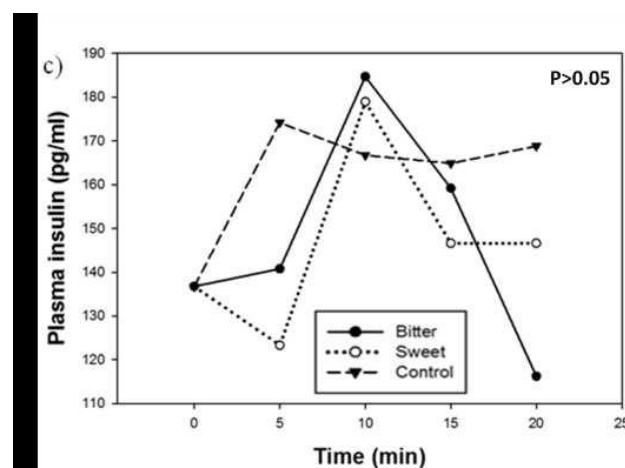


Energy intake is known to be predicted by the interaction of high food reinforcement and the inability to delay gratification (9). Therefore, the larger the k , the steeper the discounting function and the more subjects would be inclined to choose small-immediate rewards over larger-delayed rewards (10). This is in accordance with a study from Rollins et al (11), where non-obese women who showed higher discounting of future rewards had a higher EI.

Regarding insulin response (Fig 03), a different trend on insulin cephalic response was observed for the different palatable foods although no statistical significance was found.

In particular, both sweet and bitter tasting foods evoked a peak of insulin at 10 min and a successive decrease that was even dramatic for bitter.

Fig. 03. Variation vs. baseline of concentration-time response of plasma insulin after MSF of different palatable puddings.

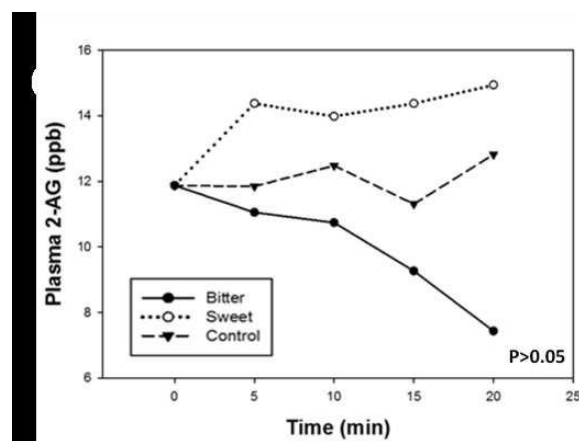


That bitter compounds might induce insulin response, as sweeteners (even stevioside), was in accordance with previous study (12). Moreover, the rapid fall of insulin at 20 min after bitter compared to sweet and control might be responsible of the increased hunger and food intake found after bitter compared to other puddings.

The higher energy intake in the ad libitum breakfast after MSF of bitter pudding can also be associated to a trend on higher ghrelin release (AUC value) of bitter taste compared to sweet and control ones. Indeed, in a recent animal study conducted by Janssen et al (13), bitter agonists stimulated the secretion of ghrelin, resulting in an increase in food intake during the first 30 min after gavage of the bitter mixture.

Recently much attention has been focused on gut endocannabinoid system as a critical component of the positive feedback mechanism that drives food intake and motivation to consume palatable foods (14). This study demonstrated a different behavior of it after MSF of sweet and bitter tastes. A relevant trend for higher total ECS release (AUC) was identified for the palatable sweet pudding, while bitter one presented lower values for all ECS analyzed (see Fig. 04 for 2-AG).

Fig. 04. Variation vs. baseline of concentration-time response of plasma 2-AG after MSF of different palatable puddings.



The same increased peripheral levels of 2-AG, but not for AEA, OEA and PEA, was characterized during the consumption of food for pleasure in a recent study from Monteleone et al (15). Furthermore, correlation analysis among ECs response (AUC) and EI (kcal) after the three different stimuli showed a significant correlation of AUC of AEA and EI only after bitter pudding ($R^2=0.72$; $p=0.023$). These findings suggest a role of ECS in modulating food intake in cephalic phase of eating palatable foods and a major contribution of AEA in stimulating food intake after unpalatable taste stimuli.

Conclusions

In conclusion, our data indicated that:

- Different palatable foods could elicit diverse gut-brain responses, even in the cephalic phase of eating
- Bitter pudding (unpalatable foods) evoked an increased response of ghrelin, which could explain the successive higher energy intake than control and sweet (palatable) puddings
- A relevant trend for higher total ECS release (AUC) was found after the sweet pudding, while bitter one presented lower values for all ECS analyzed
- AEA response after bitter pudding significantly correlated with short-term EI

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A market research on non-sticking carton packaging material for yoghurt based products for Tetra Pak

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Profile in a nutshell:

- Chemical Engineer with a specialization in Food Technology and Biotechnology.
- Well versed in process engineering concepts with sound knowledge of food products and food processing machinery.
- Specialized in the development of innovative, sustainable and healthy food products and with knowledge on food packaging design as an integrated system in a value chain.
- Seeking a long term goal as a food engineer in an R&D environment towards professional growth and development.
- Enthusiastic to work in multicultural environments.

Master Thesis Lab:

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Introduction

Large quantities of the food production are wasted throughout the supply chain, from the agricultural production down to the household consumption (Gustavsson et al., 2011). In Europe, food waste reaches up to 50% of the production considering the losses throughout the supply chain from the field up to the consumer level. Reports show that 60% of the losses at the consumer level could be avoided (European Parliament, 2011).

Packaging's Role in Food Waste

Packaging plays an important role in this problem. A household survey in Sweden in 2009-2010 showed that 20-25% of the wasted food in households could be related to packaging, while dairy products reach up to 9,5% of the total amount of wasted food in households, out of which $\frac{3}{4}$ is yogurt and sour milk. Packaging attributes to food waste can mainly be related to the packaging design. The size, sealing, way of storing, light weighing and the difficult to empty are packaging functions that can result in food waste. In addition to these, date labelling and more specifically the "use by" and "best before" dates play also an important role (Williams et al., 2012). However, one of the most crucial factors are consumers themselves. Consumer behaviour is highly important in the route for minimizing food waste, but packaging can provide the information or the technology in order to guide the consumer.

As a result, there have appeared opportunities for the packaging industry to develop packages that help towards the reduction of food waste. Tetra Pak and Arla launched in early 2013 a solution for the difficulty to empty the packages, with a



package designed to have a separable top that the consumer can remove with a perforation and squeeze the product out of the package (Tetra Pak, 2013). Furthermore, Ecolean is marketing a pitcher-shaped pouch made of a flexible material that apart from being light weighted, it is claimed that allows the consumer to remove almost 100% of the product inside (Ecolean, 2013).

Goal and Purpose of the research

The goal of this research is to understand the market for a carton packaging material that prevents food waste in order to align the material development strategy of Tetra Pak. More specifically, we are aiming at identifying the characteristics of this market in terms of consumer's value, awareness, demands and future trends, as well as to understand how the companies can help the consumers to evaluate their purchases, not only considering the product they are buying, but also the packaging at the point-of-purchase. Nevertheless, our research is limited to yogurt based products with high viscosity and the only packaging attribute that is researched is the difficulty to empty.

Methodology

For the purpose of this study we used a triangulation methodology combining both qualitative and quantitative methods. It included (a) a review on related publications on food waste and packaging, especially regarding the difficulty to empty aspect, (b) interviews with food manufacturers and influencers/experts on the matter and (c) a survey on consumers in Sweden and in the Netherlands, including both face-to-face and online questionnaires. Regarding the chosen interviewees, they were mainly selected because of their expertise in the field (both for influencers and companies) and their activities in the investigated markets (Table 1). Three key players in the dairy industry that hold a large share of the markets in Norway, Finland, Denmark and the Netherlands were chosen to represent Tetra Pak's customers. At the same time, three influencers from movements against food waste, and experts from organizations and the academia were interviewed. As for the consumer survey, we randomly chose them depending on their willingness to participate in this study.

The interview and the survey had the same content. The main topics that we investigated during the study were: (a) the market for yogurt-based products, (b) the consumer's satisfaction regarding the packaging design, (c) the consumer's behavior at the point-of-purchase and the retailer's role, (d) the relation between consumers and environmental claims and logos and finally (e) the pricing of environmental friendly packages and more specifically packages that are easy-to-empty.

Results & Discussion

Interviews

According to the respondents yogurt-based products are targeting the whole family. They are mainly used as breakfast, snacks or between meals. When it comes to packaging, 1L gable top packages represent the most common packages for spoonable yogurt in most of the investigated markets apart from Norway where this kind of package was not as successful as cups and the industry is on its way of replacing them with gable tops.

An interesting example of consumer's behavior contribution to the food waste problem that resulted from the interviews was the case of the "screw cap". Screw caps were implemented in gable top packages after consumer demand in order to facilitate sealing, storage, convenience in use and appearance of the product while used and stored. However, consumer's started eating the product directly from the packaging resulting in its contamination. In some cases, consumers were complaining that the product was spoiled before its expiry date. In addition, with the implementation of the screw cap, consumers are no longer opening the package to remove the leftover product out, since the screw cap gave them the "feeling" of an easier to empty package. At the same time, there were some environmentally concerned

consumers that complained about the presence of two different packaging materials (paperboard and plastic) that made it harder to recycle the package.

When it comes to environmental claims, we focused the interviews on the way these claims affect the decision process of the consumers at the point-of-purchase and the consumer's trust in claims coming from private companies. The interviewees claimed that they do not have a significant impact on consumers, but their absence can be considered as a disadvantage. In addition, they claimed that consumers don't have time to read the package while buying their products.

We also focused the discussion on environmental logos and the possibility of establishing a logo for food waste reduction. The interviewees appeared to be negative towards that development since there are already too many logos on packages and the consumer's understanding appears to be low (Ipsos Mori, 2008). At the same time, they believe that it would be hard to develop and certify such a comment. On the contrary, the experts believe that there could be a logo, certifying good practice against food waste taking into consideration the whole supply chain.

Finally, we discussed the role of the retailers in the food waste issue. Some of the respondents claimed that retailers do request developments towards the reduction of food waste, such as packages that prolong shelf life. At the same time, they are working with campaigns against food waste and this might appear as an opportunity for the launching of an easy-to-empty packaging solution applied in different kind of food products including yogurt-based products and custards.

Consumer survey

When consumers were asked how do they usually dispose the packaging of yogurt-based products the majority (38,3%) of the respondents in Sweden said that they usually cut, open and try to empty completely the packaging while the second most popular answer was that they squeeze the product out of the package. This points out the fact that they do realize there is an amount of the product left inside and they are making an effort to take it out. There was also a big part of the respondents (26%) that said they are just throwing away the package in the recycling after rinsing it. For this group, it is not clear whether they identify the food waste issue or not. There is the probability that they do identify it, but they don't have the time or they don't want to make the effort to take the product out, because they believe it is not a lot.

Furthermore, around 58,3% of the consumers in Sweden and 56% in the Netherlands claimed that the estimated amount of yogurt based product thrown away with the packaging, reaches up to 5% of the total product. However, research studies shows that this amount is at least 8-10% of the product in the packaging (Hansson, 2011).

In addition, around 62% of the consumers agreed that discarded food packaging is a greater environmental issue than food thrown away. Although the figures appeared improved compared to the results from similar surveys from WRAP in 2007, consumers still need to be informed. For instance, Wikström and Williams developed a life cycle assessment (LCA) model in 2010 that analyses packaging solutions with the purpose of minimizing the environmental impact of the food packaging system. Their results showed that the environmental impact of packaging can be allowed to increase if the new packaging design reduces food losses (Wikström & Williams, 2010).

Finally, 43,3% and 29,3% of the consumers in Sweden and in the Netherlands respectively, appeared to be prepared to pay more for a packaging that helps reduce food waste due to its non-sticking properties.

Concluding remarks

The main incentives for consumers when taking packaging design into consideration are convenience and money saving. This means that companies should also focus their development strategies on that area. When it comes to the carton packaging material that was researched in this study, experts believe if it is launched there will appear a “domino effect” and consumers are going to request its implementation not only in yogurt-based products but other high viscous products as well. This also means that the company that is first going to launch this will have a competitive advantage compared to the other food and packaging companies.

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Study of the Key Success factors in Early Stages of Innovation at a Global Scale

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Global scale innovation is a new topic that is continuously gaining importance among companies, moreover multinational ones. The main aspects related to innovation in general were studied as well as the most important aspect of culture and cultural differences. Many theories related to the global consumer studies were reviewed. A qualitative study was performed in order to gain more knowledge about the success factors of global innovation; a business case of PepsiCo international was executed. Semi-structured interviews of individuals involved in global scale innovation were completed. The results and analysis had an outcome of seven success factors of innovation in a sequence, and are linked between them. The purpose of the study was achieved as there was a contribution to the topic and some key success factors were identified.

Introduction

PepsiCo is the third largest food manufacturer of the world; present in more than 200 countries it has a wide portfolio of brands that are spread all over the globe. The company believes that innovation drives its expansion globally, as they develop their businesses and grow their position country by country (*PepsiCo 2011 Annual Report*).

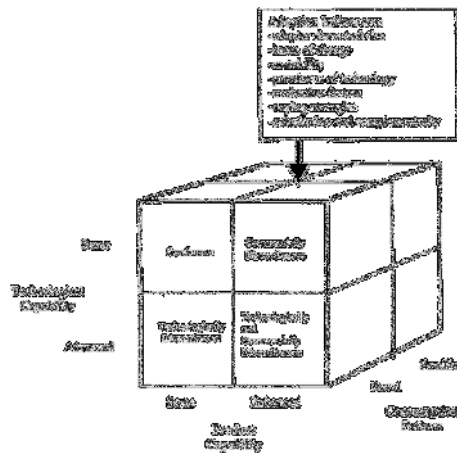
Innovation is nowadays an important asset for organizations. Geroski, Machin, and Van Reenen (1993), proved that the rate of innovation was related to profitability and that innovation employs both direct and indirect effects on firm performance.

The differences of creativity, invention and innovation were carefully studied. Innovation according to Schumpeter (1934) is:

"The commercial or industrial application of something new – new product, process or method of industrial production; a new market or source of supply; a new form of commercial, business or financial organization"

The types of innovation were identified as product, service and a combination of both (Luecke and Katz 2003; Albury 2005). The levels of innovation were as well reviewed and include incremental, discontinuous, architectural, system, radical, and disruptive (Verloop 2004). These different levels of innovation have different impact in terms of timing and profitability fig. 1

Figure 1 Levels of Innovation Veryzer 1998



of new product innovation processes. There are processes classified as linear (Sperry et al 2009) and chaotic (Khurana and Rosenthal 2007) and the difference lies in the levels of convergence and divergence in early stages. It was concluded that the best methodology approach depended on the project's aims and the level of innovation required.

The Fuzzy Front End of innovation was pointed of one of the most critical step in the whole innovation process (Sperry et al 2009).

Cultural aspects were also included in the studied. Globalization has made culture the most important asset to work with (Lee, 2004) As culture becomes an significant issue, designers have to be aware of it because after all is the creation of new products that shapes everyday lives and cultures (Moalosi et al. 2007).

Different cultural models were studied such as Hofstede's model and its five six imensions, Schwarts and its model of values and the World Map of Value proposed by Inglehart and Welzel (2010). These models group countries and cultures according to different characteristics or values.

A lack of in-depth research and appropriate methods to assist designers on how culture can be consciously integrated in product design was identified. (Onibere et al. 2001; Kotro and Pantzar, 2002). Internationalization and localization from the IT field was proposed as a possible way to perform global scale innovation.

The purpose of the study was to find the key success factors of innovation at a global scale.

Methodology

A qualitative study was performed in a top down approach. According to Patton (2001) qualitative research uses a naturalistic approach that seeks to understand phenomena in context-specific settings, like real world situations where researches don't interfere.

A case study of PepsiCo being the Global groups the business unit was performed. According to Eisenhardt (1995) the case study is a research strategy which focuses on understanding the dynamics present within single settings.

The data for the first part of the study (documentation) will be obtained from books, journals (mainly business and international marketing), doctoral thesis and other officially validated sources. Another type of data will be collected from interview made with specialists on the subject

A careful selection of senior managers and directors working for the R&D, Marketing and Insights departments was done in order to perform semi-structure interviews. The names of the respondents are to keep confidential as requested; a coded table is shown below to specify position and countries or regions of the informants. Interviews were performed either face-to-face or by telephone when it was long distance. The interview started with a short presentation of the topic as well as thanking the respondent for his time; the total length of the interviews oscillated between 30 to 40 minutes.

Finally thematic analysis was chosen as the most suitable methodology; it is a method for identifying, analyzing, and reporting patterns (themes) within data and describes this data in profound detail (Braun et al. 2006).

Results

The results were classified into three different sections: Global Innovation, Cross-cultural collaboration and Global consumers. In the Global Innovation section the aims of global innovation were studied and the main aim pointed by the informants was to find big bets and develop strategies in a global scale or for cross-cultural markets (HM, IM, SB, LR, RP, ML, 2013).



Regarding the actors in the process, many of the informants stated that at least a representative of the Insights, Marketing, R&D, Supply Chain, Finance, Operation, Sales and Commercialization departments should be involved in the innovation process (HM, SB, RP, IM, DS, IB 2013).

The challenges mentioned were to find a common food product for several countries due to the cultural differences (HM, SB, LR, RP, DS 2013), to be two-minded to think global and at a certain point localize the project (SB, LR, CA 2013). Another challenge is related to the technology capability, flexibility and availability (HM, IM, LR, RP, IB 2013). RP, IM, DS, IB 2013).

Critical tasks in early stages are market assessment, analysis of insights and building the right segmentation which are viewed as essential (SB, RP, IB 2013).

Regarding Cross-cultural Collaboration it was found that it was signaled by the informants as a challenge (IM, LR, CA 2013). Many skills were listed as fundamental for individuals participating in global innovation (HM, IM, RP, DS, LR, IB, ML, CA, SB 2013). Effective communication was one of the most repeated skills between informants (HM, RP, CA, IB 2013).

On the way of the company to build a global innovation process there is a matter that needs to be clarified and well defined. In one side global groups must work in relevant projects for several countries so a certain empowerment for them in those projects its suggested (IM, 2013).



Also SB (2013) mentions the fact that they “not invented here” syndrome should be eliminated from the mind of the people involved in the projects because it might prevent cross-cultural innovation from happening.

Alignment is needed among a greater number of people than usual and it takes time and energy a lot of resilience needed to make things or products happen (DS, 2013)

Cultural awareness is maybe the most important topic that the author wanted to explore; in the beginning the research was mostly related with consumers but throughout the research it gained more and more relevance from the collaborations point of view. This aspect was actually observed as critical from some of the informants (HM, DS, CA 2013).

Finally regarding Global Consumers, informants insisted that consumer upfront work was the most important activity in the process (HM, RP, LR, SB, IB 2013). Various sources of inspirations were discussed with the informants as well as their ways of integrating consumers in innovations processes.

It was seen that internationalization and localization practices are performed at a certain level by the company with existing brands where it is easy to do it; for some other brands and specifically for breakthrough products these practices results to be more difficult because consumer preferences and technology flexibility.

Analysis



Short-term innovation and quick results was pinpointed as part of PepsiCo’s culture and it was also mentioned that they are trying to re-adapt this culture in order to perform globally (DS, CA, LR, 2013). The author thinks that the reason of this is related to Cagesse’s study (2012) about risk management and the author suggests resilience as a first key success factor of global scale innovation supported by (DS, ML 2013).

Talking specifically about early stages the author is convinced by the informants and the theoretical framework that establishing a good vision, objective and identifying a good business opportunity, in general a good upfront consumer research cross-culturally, is indeed the second key success factor for a global scale project.

Martin et al. (2007) states that cultural competence comprises the following: cultural awareness, attitude toward cultural difference, knowledge of different cultural practices and cross-cultural skills. Cultural awareness was observed as critical from some of the informants (HM, DS, CA 2013) The author therefore states cultural competence as another key success factor for cross-market innovation and they translate this into being open minded (SB, LR, ML 2013).

Alignment of global and local teams is established as a key success factor dependent from effective communication. This fact is reinforced with theory as Koput et al. (1997) established that when goals are not clear, screening is difficult and it is not sufficient as the primary link between the flows of idea searching and implementation.

One of the similarities was found in technology flexibility as an innovation enabler (HM, RP 2013; Miles and Snow, 1996). Another similarity is the communication as a central success factor (Minaret et al. 2000; IM, 2013). Both of these aspects are marked by the author as key success factors for global innovation.



It is very clear that the informants are aware of the difference in preferences of consumers from country to country and it is known that commonalities must be found in order to perform global scale innovation. Grouping consumers in smart way is presented as the last key success factor of global scale innovation according to the author.

The most important recommendations for the company are: First is to promote cultural awareness among collaborators by giving them common training, using the existing tools for more personal communication and to help them understand each other better. The second is to work in building a model of constructive collaboration and equitable recognition when working globally.

Conclusion

The purpose of the study was achieved as there was a contribution to both academy and the industry by finding key success factors for global innovation projects. An important knowledge acquired is that global innovation is not the same as traditional one-market innovation, as there are important extra elements to be taken into account.

It is important to acknowledge that cultural competence should not be given for granted by multinational companies as it is not necessarily an automatic aspect employees learn along the way.

Finally a critical aspect is the fact of not taking into account these key success factors might prevent global innovation from happening and might also result in a waste of resources.

Future studies of how to include these factors into proper built methodology is suggested by the author.



Communication of Environmental Innovations to Consumers

A Case of Renewable Packaging for Tetra Pak

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Introduction

The interest for environmental issues is growing all around the world among consumers. Studies show that people are concerned about the protection of environment and they are changing their behavior. Increasing awareness and change in attitudes towards environment has given rise to the sustainable development and this development has stimulated environmental innovations globally in the last years. These facts are encouraging firms to change or modify their activities, including production processes, packaging and services; and eliminate their negative effect to environment by manufacturing more eco-friendly products. The growth of green marketing is an opportunity for enterprises because green strategies offer companies and retailers a competitive advantage in product differentiation and cost savings.

Packaging has a considerable possibility to contribute to a sustainable development and consumer demands for sustainable packaging are being felt across the supply chain. The main goals in sustainable packaging are minimizing material use and waste, substituting traditional, contaminating materials with new, ecologically friendly ones that will pass through sustainable production processes, and that are possible to renew and recycle as high a percentage of packages as possible.

Trends in consumer packaging market are affected by changing consumer demographics and behavioral patterns; however, sustainability and the cost of raw materials are the drivers that concern the aim of this project most. Therefore, natural resources are becoming more valuable. Global companies like Coca-Cola and Tetra Pak and other companies launched their packaging with increased renewable content by using sugar cane derivatives instead of traditional resources.



This change in packaging material helped them to reduce the greenhouse gases since it is a renewable resource.

Tetra Pak & Purpose of the Research

As one of the leader companies in packaging industry Tetra Pak introduced their 2020 strategy which puts the company's environmental ambitions at the heart of its business. In the line of this strategy, the company aims to develop packaging based on 100% renewable materials. The purpose of this thesis is to investigate how a brand owner using renewable packaging material can communicate this and its higher value (compared to traditional packaging) to consumers, in order to help consumers make more conscious choice when buying food products. Furthermore, this master thesis would provide external data about renewable packaging by gathering academic and business-oriented publications related to the topic and by interviewing outside sources on the subject from business, academics and non-profit organizations.



Methodology

To fulfill the aim of the thesis a qualitative research strategy was employed. Both primary and secondary data were collected in this study. An exploratory research was done through a qualitative approach, involving literature review and empirical research in the form of semi-structured interviews with managers and experts across the actors of packaging value chain. Interviews were carried out with respondents using mostly open-ended questions to collect in-depth knowledge and facts about their current projects regarding the renewable materials and consumer studies conducted by their institutions. These findings provided a holistic view about renewable packaging and an understanding of how to communicate environmental innovations to consumers. The main topics that are investigated during the study were the market for environmental packaging and consumer awareness towards these products, the understanding of environmental claims among consumers, contribution of packaging into sustainable development and more specifically higher renewable content in packaging, and finally the pricing of environmental friendly packages.

Results

According to respondents, consumers are getting more aware of environmental issues and there is a growing demand for products with better environmental attributes. However, consumers are different and they value different things. Interviewees explained further that for the vast majority of consumers, including various consumer groups, their product choices are motivated by different factors. Other product attributes such as quality, price, and availability in store comes before environment for consumers. Participants mentioned that they conduct consumer researches in order to get consumer insight better and to understand what consumers think regarding packaging and what consumer expectations from packaging are. Many of the informants stated that green products are perceived by many consumers as premium and this perception causes them to think that these products are expensive. Furthermore they added that a niche segment would be willing to pay extra for a packaging with better environmental attributes; however, they added that it won't be more than 10 per cent of total product price.

Interviewees pointed that renewable materials are becoming more popular in the packaging industry. Consumer demands, environmental issues and increasing price of non-renewable resources have emerged using bio-based materials in packaging industry; and global companies are pioneers of this trend by using bio-based plastics. Participants agree that the importance of sustainability will continue to grow and the packaging industry will be influenced by this tendency and there will be more bio-based materials.



When it comes to environmental claims, the respondents affirmed that as the numbers of environmental symbols in the marketplace continue to increase, consumers are getting more confused. Although these symbols are recognized by some consumers, the consumers do not exactly know what these logos stand for; what they understand is mostly that it is good for the environment. Instead these claims, brand owners will try to fill in their own brands with environmentally friendly, positive image according to interviewees.

Regarding the increase in awareness, participants stated that when the consumers would know and understand more about sustainability and its benefits, their awareness degree would increase and it will impact their behavior. The important issue is to educate the public, making messages about environmental advantages easy to comprehend. All the interviewees agreed that the message sent to consumers should be simple and easy to comprehend so that consumers would understand how they would benefit from that environmental innovation.

Discussion

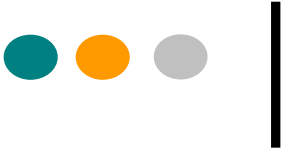

Consumers are different and they value different things; therefore in marketing research, consumers are divided into segments that have similar expectations. In this study three main segments were found in the interviews. According to the researcher, these segments could be classified as either green, yellow or red consumers, depending on their interest in environmental products. What is important to note for all these groups, however, is that none of the groups think that the environmental aspect of packaging is the most important feature of a product.

The green consumer segment does value products with environmental attributes, and this is one of the characteristics that they look for when purchasing products. This segment is willing to pay more for the sustainable aspects of a product, which may include environmentally friendly packaging according to market reports. On the other hand, the yellow consumer group, which includes larger amount of people, care about environmental issues as well; but the difference from green consumers is that they don't act upon their beliefs in their daily purchasing decisions. When it comes to paying premium for sustainable packaging, this segment might have some doubts. The last segment of consumers is the red consumer segment; those that are not concerned about environment and do not consider buying environmentally friendly products.

Regarding renewability, when the researcher asked about renewable packaging material during the interviews, the participants, after saying a few things on renewability, proceeded to mention other contributions a sustainable packaging can have like light weighing. It gives an insight that the term "renewability" is not yet a well-established concept in people's mind. This is probably valid for consumers as well; they are not yet familiar with renewability, and may not differentiate this from common environmental concerns, such as recyclability. Thus, a survey conducted by Tetra Pak shows that many consumers around the world do not understand the concept of renewability, often confusing it with recycling.

Increased demand on environmentally friendly products might present an opportunity for companies if they have the courage to take the first step. With sustainable packaging, they would have a chance to attract the consumers who are environmentally conscious. Moreover, with reasonable prices they can have a competitive advantage and increase their market share by being socially and environmentally responsible.

Concerning the reviewed literature and the conducted interviews, it could be said that there seem to be two forms of information; information based on *facts* like knowledge and information based on *emotions*. These two kinds of information are the factors that affect consumers' knowledge, attitude, and behavior towards environmentally benign products. Therefore, it is essential to educate the public and



make messages about environmental advantages easy to comprehend. Regarding the information based on emotions, it is meant that products or brands can create an emotional effect on consumers by advertising or marketing.

Increasing knowledge is important, however if we think upon consumer segments, we can say that the green segment already is aware of many facts regarding environmental benefits of sustainable packaging, and they are acting accordingly. On the other hand, the yellow consumer segment is also aware of these issues, but the difference is they don't translate this belief into action. The researcher believes what is needed to stimulate this consumer group is another motive, a driver. The message that the product is giving to consumers has to address the emotional context of their needs that their product choice will make a positive impact in the environment, or making them feel good as they are doing something right for the environment through this small purchase. When it comes to the red consumer segment which has limited information about environmental issues, they are the ones who will be most influenced by information based on facts. Informing them about environmental issues could have a real effect on this consumer segment as they could gain a lot from this information and this situation might affect their attitude towards environmentally friendly products.

Regarding the information based on emotions, it is meant that products or brands can create an emotional effect on consumers by advertising or marketing, and this actually can affect all the consumer segments. For example, for the green group, they already consider environmentally friendly packaging when they are making their purchase decisions, although this is not the primary driver. These well-informed consumers can perhaps be targeted instead through their emotions to make them prioritize the environmental aspect of packaging. Likewise, using emotions through marketing and advertising could be the driver for yellow group that would make them behave according their beliefs. The yellow segment would probably be the best target for these advertisements because they are already aware of environmental issues; and this could influence them to change their purchase behavior. For the red consumer group, although they have limited information about environmental issues and don't consider this aspect in their purchasing decisions, the emotional aspect can be targeted so that they would want to buy a product for other reasons aside from its environmental benefits.

Concluding Remarks

As being environmentally friendly becoming more important in consumers' perceptions; brands would like to be associated in peoples mind as being a green company or brand. In that challenge, a brand that makes environmentally smarter choices, in its production processes, packaging material or transportation etc. and combines all these attributes in a credible way would be valued by consumers. And as this trend, being environmentally friendly, keeps growing there will be a time that it will become a "must-be" quality attribute of the product. Today, being environmentally friendly can help brands to differentiate themselves from competitors, probably making a profit out of it. They can attract consumers who value these products and who are willing to pay a premium for it.

Another point that needs to be highlighted is that consumers would not buy a product just because of its environmental packaging; therefore, this feature has to be combined with high quality product content and excellent branding. Moreover, product content has to be in premium segment like organic, fair trade, or flavored products because this is what the consumer is actually buying. Packaging on its own doesn't make a huge difference in consumers purchasing decision, but combining it with other strong environmental attributes will create a holistic proposition that is very compelling.



Sustainable Development & Food Reinventing the school meal through public procurement practices: The case of Malmö

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Feeding a sustainable future

Food plays a very vital role in the life of every human being. Simultaneously, human expansion and urbanization are rapid happening phenomena; as a result, contemporary and future urban food supply has to be reassessed in order to make sure food provision on urban settlements guarantees a fair access to healthy and nutritious food products to all its dwellers, at the same time as fostering sustainable development processes. Fortunately, a number of initiatives to confront these issues have already been formulated and they are characterized for having a holistic vision of sustainability, stressing equal importance on the different dimensions conforming the concept. As part of these innovative urban food strategies, the importance of municipalities as food policy makers is mounting; recognizing the potential of reevaluating public food procurement as a mean to establish new relations between the public sector -a very powerful buyer and consumer of food products- and the influence it has on shaping the future of urban food systems. Most importantly, the resounding interest that societies have paid to food on the past couple of years has finally reached one interesting realm, fundamental in the attainment of a sustainable future represented on the most vulnerable sector of society: the school meals program (Morgan, 2006).

The Case of Malmö

The city of Malmö, the third largest urban hub located in southern Sweden, has succeeded on recognizing the importance of food on achieving sustainability enacting in 2010 a Policy for Sustainable Development and Food that aims at addressing the environmental impacts due to food related activities in addition to instilling in its citizens food consumption habits that consider a whole life costing evaluation of their actions instead of the solely price approach that



currently prevails. Two main clear goals to be achieved by 2020 guide this policy: the reduction of 40% of the greenhouse gas emissions due to food related activities (considering 2002 levels) and 100% certified organic food served in the City of Malmö. The Environment Department of the municipality, on response to the scope of its endeavors, is in charge of monitoring the progress of the city on attaining the policy goals. The preschools institutions of Malmö are in fact one of the main arenas of involvement for the Environment Department in this regard due to the different inherent characteristics of Malmö's preschool catering sector demanding greater attention and efforts from pertinent authorities. Indeed, the Environment Department coordinates activities in order to increase awareness, and in collaboration with different actors involved on the preschool catering service of the city, communicates information striving at inspiring the sector with sustainability knowledge pertinent to the span of their responsibilities.

Objectives

The overarching objective of this research is to provide a general view of the sustainable food procurement practices on the Swedish public sector. The case of the city of Malmö will be used as a framework offering a focus for the research, in this case, the preschool catering sector and the target of 100% organic foods, identifying key actions, focusing on opportunities and constraints that are defining these institutions' purchase actions. A parallel aim consists on providing the Environment Department with valuable information in order to develop strategies to overcome obstacles faced by the preschool catering sector scaling up the policy results. In order to achieve this, it is basic to identify and understand the various factors affecting the purchasing choices of the final decision makers when it comes to public procurement. Accordingly, it is important to describe as closely as possible the activities the partakers follow during the purchasing process, while aiming at answering the following underlying question:

What are the factors defining the ultimate purchasing decision of public food procurers as regards whether or not buying organic foodstuffs?

The results can hopefully reveal how Malmö preschools can increase the level of implementing sustainability considerations during their food procurement process in order to develop best practice towards a higher level of organic products purchased.

Methodology

First, an exhaustive desktop literature review was conducted. This newly acquired knowledge allowed for the formulation of different questions for qualitative semi-structured interviews to happen following. To gain complementary insights that allow for a systemic vision of the process, the interview respondents included several public servers at different stages of procurement with activities potentially influencing the final results of the purchasing process. This comprised Malmö City Environment Department staff, Environment Coordinators of different city districts, Head teachers and preschool's catering personnel.

The sampling methodology was based on the statistical results available through the Environment Department reports, showing the district's performance as regards organic foodstuffs purchased on previous years that allow for the identification of the districts with better results so as rocketing ones. Based mainly on this information, a second approach to Environmental Coordinators on different city districts allowed for a closer view of the situation, and served as a bridge for contacting cooks and preschool personnel. Therefore, the interviews show the insights of procurement participants from different perspectives; however, the study does not denote a statistically representative analysis of the entire preschool catering sector in Malmö as such, but rather provides a deeper understanding of specific conditions of outstanding examples.

The analytical tool used is largely based on the Hurdle Analysis Method developed by Gunther & Scheibe (2006) from Dresden University, an instrument designed for municipalities to be able to identify and relieve by themselves the hurdles encountered during the implementation of Green Public Procurement strategies.

Results & Discussion

In response to the research question the following was encountered:

Personal motivation of the individual in charge of procurement is the main determinant of purchasing results. With this in mind, goal redesign of the preschool catering sector can be motivated by the next findings:

- A dominant concern of the health implications related to the food provided to the kids.
- Social pressures in the form of opinions from co-workers.
- The recognition of their jobs by the society.

The extra price hurdle associated with purchasing organic produce has to be discredited. Three alternatives to do so are presented:

- Publicize successful cases.
- Knowing the budget.
- Recognition of professional skills on the caterers.

Upper management's, named the preschool head, support and attitudes towards organic are enablers; yet not determinants.

Lack of representation from an appointed leader is discouraging. More than a current defining factor of the procurement decisions, this is rather seen as an opportunity to further boost the aforementioned strategies. Thus, selecting a head of the sector can allow for certain alternatives identified during the research to be put in practice comprehensively:

- The creation of a network can result on improved communication mechanisms, common base and best practice share.

These findings responded from different angles the initial research queries. Over the construction of the findings the influence of the staff status as a motivator of change was unquestionable. Finally, even when it seems unlikely that a universally valid strategy for overcoming the identified hurdles can be developed, individual strategies can be designed as long as the proper information is made available and motivation is stirred adequately.

Conclusions & Further research

The mere fact that the phenomenon under research constitutes an emerging transformation of an existing regime of practices, an ongoing and dynamic policy intervention, represents an opportunity for improvement per-se. The decisive global reorganization about to happen at the municipal level has already succeeded in recognizing the relevance of food in public institutions assigning an entity for the supervision of such related activities: the department for Physical Environment. This has the potential of shuddering even more the microcosms of preschools, and in order to do so with a deeper understanding of the current situation, this descriptive examination can be useful as a starting point for further research regarding the implications of the implementation of this new department. The findings presented here could be studied with the purpose of determining effective further strategies in order to achieve sustainable awareness and increased commitment of the preschool catering sector at least.

Besides, the evaluation of the actual carbon reduction resulting from the change in procurement practices is definitely worth exploring as a tangible result that can steer further motivation. Additional further research regarding the social implications of sustainability on the procurement practices of caterers can be an interesting completing dimension of the process, since this subject was barely approached and still constitutes a TBL sustainability component. Last but not least, the actual potential and results of the pedagogic meals as regards children's eating habits and potential future consumption behaviors will represent the most interesting and purposeful study.



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Application of temporal dominance of sensation (TDS) to the study of a coffee based frozen cream

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Profile in a nutshell:

- Food safety and quality
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- Baking
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The main objectives of this study were to apply temporal dominance of sensations (TDS), a dynamic sensory analysis technique, to investigate the influence of emulsifiers on the sensory properties of a coffee based frozen cream (CBFC), and to eventually verify the feasibility of producing emulsifier-free CBFC, which can be delivered to consumers with no detectable differences. The results of three different types of TDS curves demonstrated that emulsifiers played an important role in the temporal evolution of CBFC's dominant attributes, and the absence of emulsifiers also altered the existing product inconsistency originated from dose (the amount of cream mix inside the granita machine) change. Consequently, the inclusion of emulsifiers in the recipe of CBFC was essential. Statistical analysis on aggregated frequency value showed that the list of attributes had been well generated and most judges had been well trained.

Introduction

Emulsifiers are included in CBFC's recipe given their functions in product stabilization'. However, there is an ever growing demand from consumers for all-natural foods free of certain additives. It was under this circumstance that we proposed to test the possibility of producing emulsifier-free CBFC without modifying its original sensory characteristics, and possibly without altering the inevitable existing product inconsistency originated from dose (the amount of cream mix) difference. To achieve these targets, a temporal sensory technique called Temporal Dominance of Sensations (TDS) was utilized.

Objective

This study is aimed at applying TDS, which has been applied successfully to some semi-solid products^{2,3}, to study how emulsifiers would impact CBFC's sensory traits and to verify the feasibility of producing emulsifier-free CBFC.

Materials and methods

Whole fresh milk and pasteurized skimmed milk were purchased in a local supermarket. Two kinds of CBFC powder and three granita machines were provided by R&I department of the company.

Preliminary experiments were carried out to select the most suitable spoon and tasting protocol for CBFC. A total of 12 sessions were conducted for TDS analysis, including 6 sessions of training and 6 sessions of formal assessment. During training, a list of ten attributes was generated and was later used in formal tests. Six samples (**Table 1**) were evaluated by 16 judges in triplicate over six 30min sessions with 3 samples in each.

Table 1 CBFC Samples Used for TDS Analysis

Sample	Presence of emulsifier in CBFC powder	Amount of CBFC mix inside the machine before evaluation
1	+	Whole dose*
2	+	2/3 dose
3	+	1/3 dose
4	-	Whole dose
5	-	2/3 dose
6	-	1/3 dose

*whole dose= 4kg CBFC mix (1kg CBFC powder + 3L fresh whole milk)

Sample presentation was randomized across judges and sessions following a Latin Square Design. Samples were served at $-3.6^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ with a standard volume of $10.2\text{ml} \pm 0.4\text{ml}$. Assessors were instructed to indicate the perceived dominant sensations at any point of time while performing the standard tasting protocol. Data was collected with FIZZ software with a fixed interval of 0.5s. Data acquisition automatically stopped after 60s but judges could stop it when no more sensations were detected.

Collected raw data (0= not selected as dominant, 1= selected as dominant) were further processed in Excel to construct TDS curves⁴, TDS difference curves and average TDS curves⁵, from which the sequence of dominant sensations stimulated by each sample could be obtained and compared.

Results and discussions

Dominance rate of each attribute was plotted against time in TDS curves. Attributes with a DR of less than chance level were non-dominant ones, and vice versa. It is obvious that the curves in **Fig.1** vary in terms of colors (types of dominant attributes) and shapes (dominance rates). To get a clearer picture concerning sample differences, 9 TDS difference curves were constructed for pairwise comparisons and results were exhibited in **Fig. 2** and **Fig. 3**.

Fig. 1 TDS curves for each sample

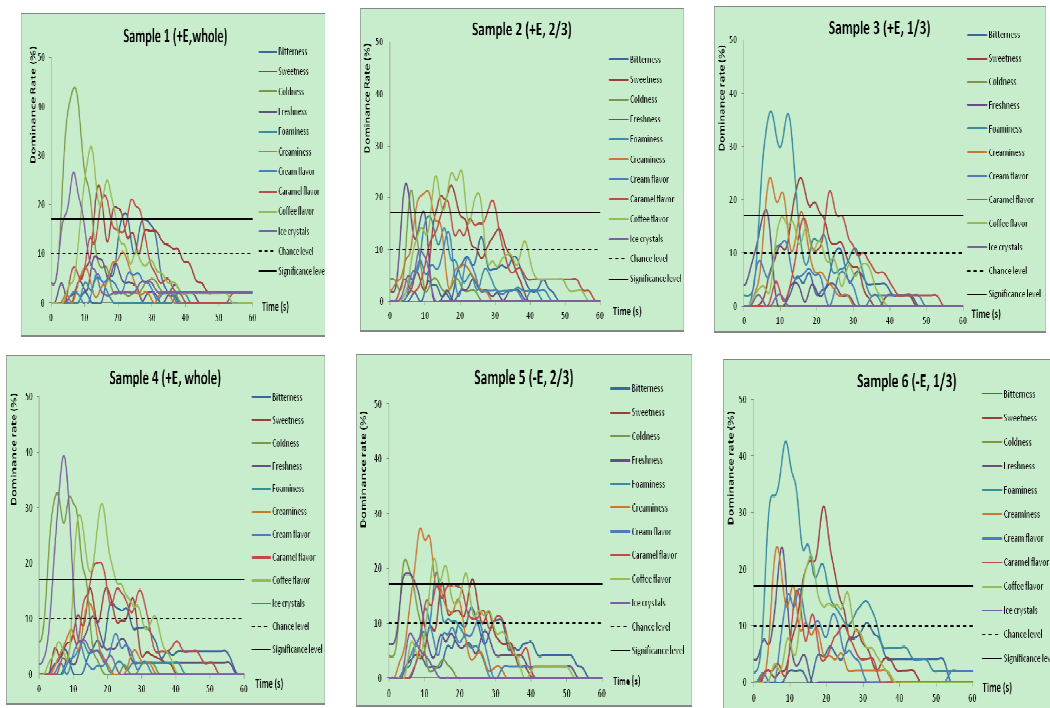
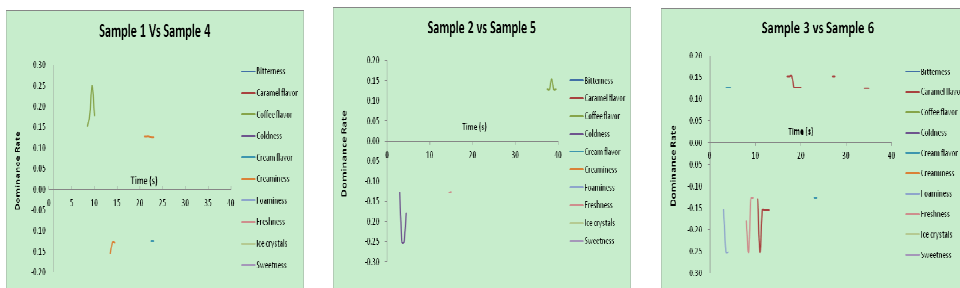
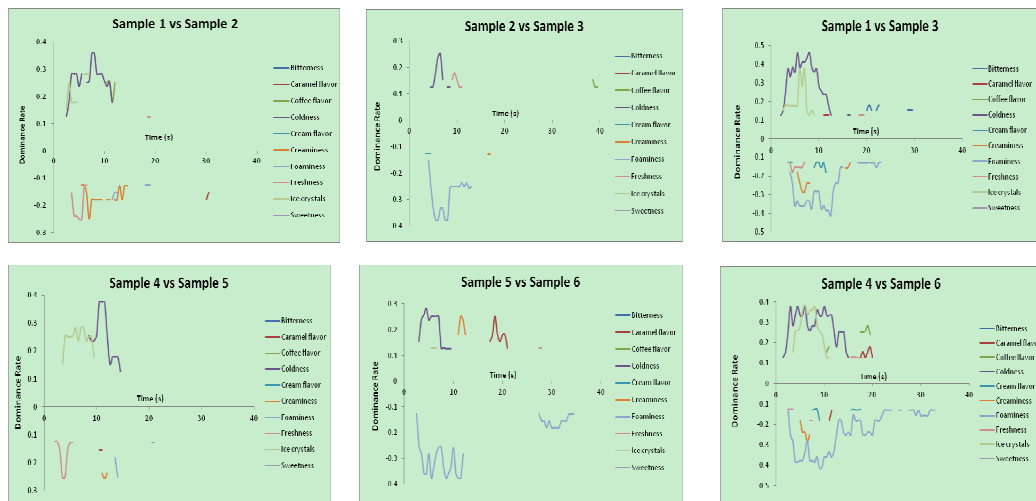


Fig. 2 TDS difference curves to study emulsifier effect



It can be seen from Fig. 2 that for each fixed dose, the absence of emulsifier brought about significant differences for several attributes, including coffee flavor, the most important attribute for CBFC as it is a coffee-based product. Besides, more differences were highlighted in the case of 1/3 dose, which was expected since there was a 20% difference in the overrun of the two samples. This further confirmed TDS's suitability and capability of distinguishing sample differences.

Fig. 3 TDS difference curves to study dose effect



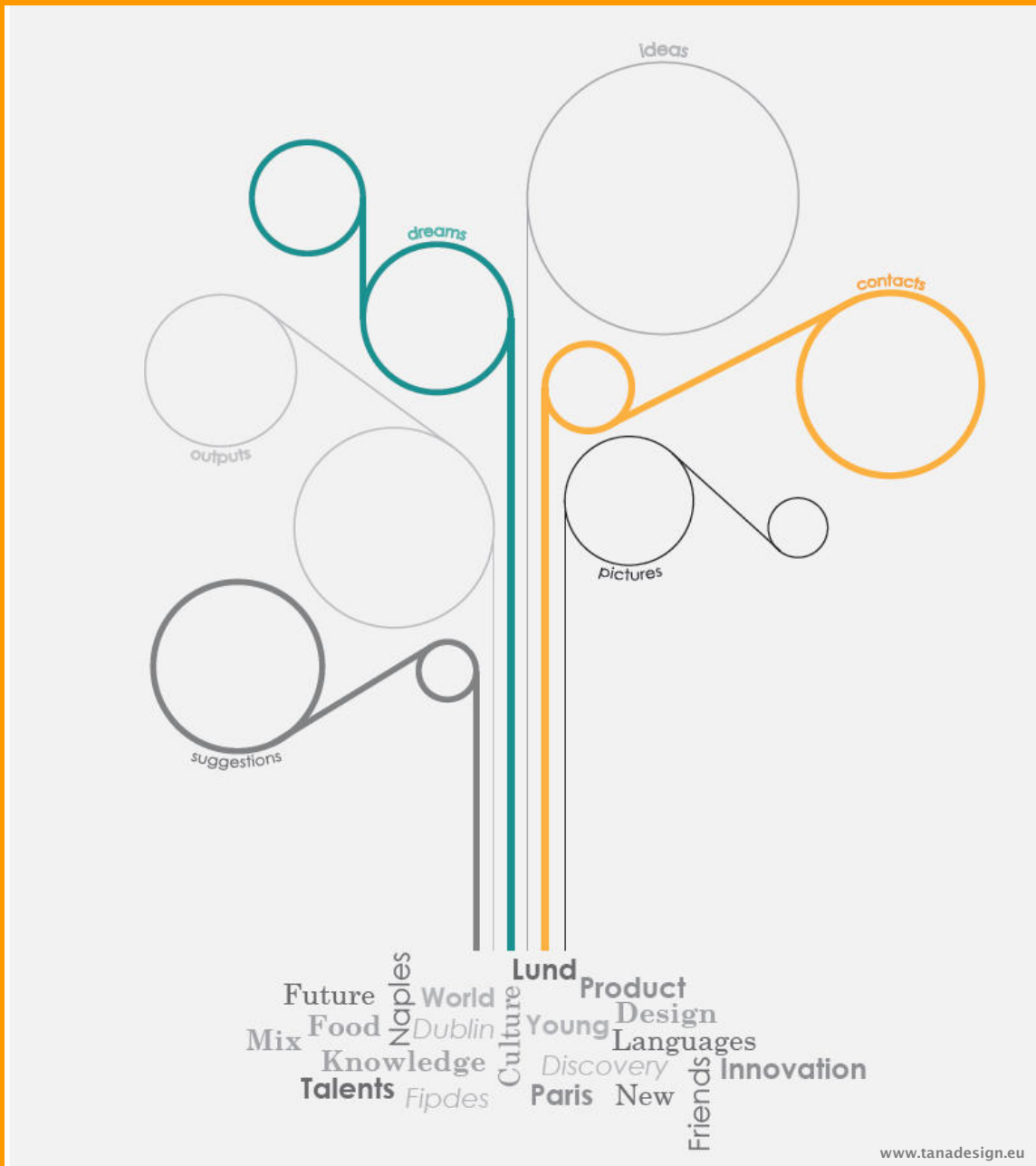
By comparing the 6 curves in **Fig. 3** horizontally, we could tell that there was a general trend in both recipes that samples with less does were mainly more dominated by creaminess and foaminess but less dominated by coldness and ice crystals. However, when comparing the curves vertically, we found out that the absence of emulsifier actually changed the inevitable product differences that were originated from dose difference.

Conclusions

TDS was capable of identifying differences among CBFC samples concerning the temporal evolution of dominant sensations. The presence of emulsifier in the recipe of CBFC was essential and chances were little to produce emulsifier-free CBFC.

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