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„Reformulating Food Production Concepts to Improve the Diet Quality in Europe

(From theory to practice – based on the project FOOD PRO-FIT)“

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IV. Abbreviations

The following abbreviations are used in this dissertation:

CHD	coronary heart disease
CVDs	cardiovascular diseases
DALYs	disability adjusted life-years
FNO	food nutritional objective
FSU	free sugar
HACCP	Hazard Analysis and Critical Control Points
HANCP	Hazard Analysis and Nutritional Control Points
HORECA	Hotels, Restaurants and Caterer
LDL	low-density lipoprotein
MUFAs	monounsaturated fatty acids
NCDs	non-communicable diseases
NPCs	Nutritional Performance Criteria
PUFAs	polyunsaturated fatty acids
SFAs	saturated fatty acids
SMEs	small and medium sized enterprises
WONRAC	Workplace Nutritional Risk Assessment and Control

1. INTRODUCTION AND RESEARCH QUESTIONS

According to the report of a joint WHO/FAO Expert Consultation from 2003, the percentage of chronic non-communicable diseases (NCDs) within the global burden of disease is likely to increase from 46% to 57% by 2020 [WHO, 2003a]. The former burdens nutrient-deficiency or infectious diseases give way to high incidence rates of cancer, coronary heart disease and obesity – not only in elderly but also already in children [DREWNOWSKI, 2000]. In view of the current burden of NCDs (accountable for 60% of the 65.5 million reported deaths worldwide) and the predicted rise of mortality attributable to cardiovascular disease (CVD), diabetes mellitus, obesity and other nutrition associated chronic diseases [WHO, 2003a], it is indispensable to review existing prevention strategies and look for new possibilities.

Problem identification. Chronic non-communicable diseases like CVD, obesity, diabetes mellitus and some types of cancer are public health concerns with multifactorial aetiology: Social factors like cultural and environmental circumstances, biological factors including for instance overweight or hypertension, as well as the behavioural aspects in terms of dietary habits and physical activity can influence the risk for developing NCDs [WHO, 2003a]. In most cases the risk is related to nine changeable factors, which are smoking, poor diet, high blood cholesterol, high blood pressure, insufficient physical activity, overweight, diabetes, psychosocial stress and excessive alcohol consumption. The reduction of one of these factors could significantly reduce the likelihood of developing chronic NCDs and thereby decrease the risk for premature disability and death [NHS, 2010].

In addition to the three major diet-related non communicable diseases – CVD, diabetes and cancer – diet plays a decisive role in the development of other diseases like osteoporosis, hypertension and stroke. About 30 to 40% of several cancers and 30% of lethal cardiovascular events could be prevented with healthy nutrition and an active lifestyle [EURODIET, 2000]. Besides accounting for a considerable number of “disability-adjusted lost life-years” (about 5% attributable to poor nutrition), the treatment costs for these diseases “gobble” about 30% of the national health costs in some European countries and will soon be overwhelming [WHO, 2002]. Primary prevention of these principally preventable diseases would be the most cost-effective and sustainable strategy [WHO, 2003a].

Food availability and accessibility are requirements for the implementation of healthy diets and two of the most powerful factors to influence diet quality and individual health: For instance, the rise in fat availability in developed countries came along with increased incidence of chronic diseases [ANDERSON and ZLOTKIN, 2000].

The creation of health-supporting environments should include supporting the availability and accessibility of healthy, nutrient dense foods followed by nutritional information at the point of purchase, reduction of portion sizes and reformulation of “unhealthy” foods into healthier, less salty and less sugared options. High food quality is an essential condition in improving the diet quality and promoting health. A change of actual macro- and microenvironments into enabling surroundings would facilitate the adoption of recommendations on individual and population level [WHO, 2003a; LICHTENSTEIN et al., 2006].

Research questions. In view of the burden of NCDs and the need for new prevention techniques establishing health-supporting environments, the European project “FOOD PRO-FIT” (2006 340) [PHEA, 2007] aimed to create an innovative tool for small and medium sized enterprises (SMEs), helping these to improve the nutritional quality of dishes and products and to make the healthier choice the easiest choice for the consumers. Therefore, the main objective of this dissertation is to assess the feasibility and acceptance of this concept as new prevention technique.

In the course of this dissertation the various steps of development from theory to practice shall be described and analyzed: What are the consumers’ perceptions of healthy food and how is their food choice influenced? From the perspective of SMEs, which actions have to be taken to improve the diet quality in Europe and how can these strategies be put into practice?

Moreover, the relevance and usability of the tool developed during the pilot project and the incorporated recommendations fixed by the “FOOD PRO-FIT” consortium for the participating companies are to be evaluated: Is it feasible to put this concept into practice considering technological, commercial and safety aspects? What are the strengths and the potential of the tool? Which problems and limitations occurred during the implementation and are there ways for improvement? Are the reformulated products and dishes accepted by the consumers? And finally, is the tool sustainable?

2. LITERATURE SURVEY

2.1. The role of sodium, SFAs and sugar in the development of chronic NCDs

The optimization of dietary quality and nutrition action together with life style interventions can significantly decrease the risk for various NCDs or even ameliorate the progression. High dietary diversity in combination with elimination of nutritional risk factors is an essential aspect for health promotion [ELMADFA and FREISLING, 2005].

In this dissertation the focus is laid on the importance of so-called “disease-related nutrients” or nutrients associated with negative effects on health. In this regard, studies have highlighted the three nutrients saturated fatty acids (SFAs), sodium (Na) and sugar to play a major role in the most prominent nutrition-related chronic diseases (Table 1).

Table 1: Health risks of popular disease-related nutrients [WHO, 2003a]

Nutrient	Health risk	Evidence	Effects	Comments
Sugar	Dental disease Obesity	convincing probable	anaerobic metabolism weight gain	Amount vs. frequency Energy dense foods, sugared soft drinks
Sodium	CVD Stomach cancer Osteoporosis	convincing probable possible	Blood pressure ↑ ↑ urinary Ca-excretion	Salt-preserved foods High sodium intake
SFAs	CVD Type II diabetes	convincing probable	Cholesterol ↑, LDL ↑ impaired glucose tolerance, ↑ fasting glucose and insulin levels	PUFAs to replace SFAs

2.1.1. Nutrition associated chronic diseases

Obesity. Weight gain, overweight and obesity are risk factors for many chronic NCDs like diabetes, cancer or CVDs and the co-morbidities dyslipoproteinaemia, gout, high blood pressure, atherosclerosis, hormonal disorders etc. Therefore stabilization and normalisation of weight is indispensable in health promotion strategies [WHO, 2003a]. About half of the European adults and one in five children are overweight or obese. Obesity accounts for the loss of about 5% of disability adjusted life-years

(DALYs) in the European Union and 2.5 billion Euros health costs per year including direct and indirect costs [WHO, 2002].

Due to urbanization and modernisation, our society has created an obesity promoting, so-called “obesogenic environment”, in which the incidence of obesity is estimated to be doubling every five years. In addition to low physical activity levels, bad eating habits with lots of processed foods including high amounts of sugar and fat are blamed for the actual pandemic dimension of overweight and obesity [CHOPRA, 2002]. There is evidence that the nutrient sugar, mainly added to foods and drinks such as sugared soft drinks, probably increases the risk for obesity. Every additional sugar-sweetened soft drink daily increases the risk for obesity by 60% in children [WHO, 2003a]. He et al. pointed out that a reduction in salt would lead to less consumption of soft drinks in adults and in children and therefore reduces the risk for obesity: Ingestion of only half of the actual average daily salt intake would result in a reduction of about 80ml sugar sweetened soft drinks in children per day (about 35kcal) and about 100ml in adults. A reduction in soft drink intake in conjunction with salt would be beneficial to preventing obesity and cardiovascular disease (additional effect of salt besides reducing the blood pressure) [HE et al., 2008].

Many strategies to improve the epidemic situation of obesity e.g. by ameliorating nutritional knowledge and personal attempts to reduce weight have failed because of the “seductive” and unsupportive, obesogenic environment: In America there are about 170,000 fast food chains and three million vending machines contributing to “away-from-home-eating” [CHOPRA, 2002]. Changing this obesogenic environment and improving the diet quality using a mix of education strategies and regulations in the food sector could reverse the actual trends and reduce the number of obese and overweight people. Although challenging, positive examples in Europe such as Norway or Finland confirm the hypothesis that environmental changes could improve the diet quality and strengthen the importance of reducing the availability of high fat, energy dense foods [CHOPRA, 2002; McNAUGHTON et al., 2009].

Diabetes mellitus. Due to excessive energy intake, low physical activity levels and sedentary lifestyle, the number of adult diabetics is expected to rise steadily to about 300 million until 2025 [TULLAO, 2002]. Therefore, lifestyle changes are indispensable in reducing the risk for diabetes, especially for the reduction of weight convincing evidence is given: Obesity and inactivity are significantly related to insulin resistance and the incidence of diabetes (type 2) [AROLA et al., 2009].

The consumption of energy-dense foods and high amounts of saturated fatty acids (SFAs) probably increases the risk for impaired glucose tolerance and could lead to higher fasting glucose as well as insulin levels [WHO, 2003a]. In contrast, men and women with high qualitative diets have significantly lower fasting plasma glucose and insulin levels. Higher diet quality also resulted in greater insulin sensitivity in women and lower prevalence rates of diabetes mellitus in men [McNAUGHTON et al., 2009]. When SFAs were replaced by unsaturated fatty acids, the glucose tolerance and insulin sensitivity could be improved. Therefore, the WHO recommends intake levels of <7% of total energy from SFAs for people at high risk [WHO, 2003a]. The adverse effects of sugar in the development of diabetes are not sufficiently evident [AROLA et al., 2009]. There is only probable evidence, that the consumption of sugared drinks could increase the risk for diabetes [EFSA, 2009].

Cardiovascular disease. In Europe, more than 4 million deaths per year, about one-third of all deaths, are attributable to CVDs including stroke, coronary heart disease and peripheral arterial disease. Coronary heart disease is leading the list of causes for premature deaths worldwide [WHO, 2002].

About 30% of CVDs could be prevented by a high diet quality [WHO, 2002]. The diet-related atherogenic risk factors overweight and obesity, hypertension, increased blood lipids and diabetes increase the risk for CVDs. In order to reduce these co-morbidities and the risk for CVDs, weight loss and high diet quality with low intakes of SFAs, sodium and sugar have to be aimed at [WHO, 2003a]. Among men, a high qualitative diet leads to significantly lower systolic and diastolic blood pressure and lower prevalence of hypertension [McNAUGHTON et al., 2009].

Myristic and palmitic acid are the main SFAs impairing LDL and total cholesterol levels and should be replaced by polyunsaturated fatty acids in order to reduce the atherogenic risk. So, the intake of fat from milk and meat products and hydrogenated oils should be limited and substituted by vegetable oils and fish. Moreover, about 50% of hypertensive patients could do without medication and several deaths through CVDs could be prevented, when reducing the daily sodium intake by at least 1.2g. A sodium intake reduced by about 2g per day could lower the blood pressure in normo- and hypertensive patients. Children as well as the elderly would profit from the positive effects of low sodium diets (1.7g sodium) and a salt reduction to less than 5g per day on the blood pressure [WHO, 2003a].

In order to prevent CVDs it is important to maintain healthy body weight, to ingest a diet rich in vegetables and fruits, to reduce the daily intake of SFAs, to choose lean meats, low-fat dairy products and vegetable oils instead of solid fats, to cut down on sugared drinks and foods and economize the use of salt [LICHTENSTEIN et al., 2006].

Cancer. Diet quality and nutritional aspects play a decisive role in the cancerogenesis, especially in the initiation phase, and are the most important preventative factors after smoking. About 30% of cancers are associated with adverse dietary factors like excessive salt and overweight because of energy imbalance. The risk for cancer of the oesophagus, colorectum, kidney and breast (in menopausal women) is significantly increased by overweight and obesity. Moreover high-consumers of salt-preserved foods and salt in general are probably more likely to come down with stomach cancer [WHO, 2003a]. The amount and quality of fat influence the risk for cancer of the pancreas, colon and prostate [TULLAO, 2002]. Therefore, the World Cancer Research Fund and American Institute for Cancer Research recommend to reduce the intake of sweetened beverages and energy dense foods, as well as to cut down on dietary fat, salt and red and processed meat [WCRF, 2007].

Dental diseases. The development and severity of dental diseases depends on various factors: Besides nutritional aspects, genetic predisposition and the function of salivary glands as well as the degree of oral hygiene and availability of fluoride have an impact on the probability for caries and dental erosion. In children with low degree of oral hygiene (teeth brushed <2 times/d), high intake of sweets and sugar containing drinks was associated with higher prevalence of caries [WILLIAMS, 2001; PALOU et al., 2009].

Organic acids, the main products of metabolism from sugars by plaque bacteria, can demineralise the enamel and dentine and lead to caries. As fermentable carbohydrates are necessary for the causation of caries, sugar intake influences tooth decay. There is a strong correlation between the amount and the frequency of sugar intake and caries: In countries with daily free sugar intakes below 10%E, dental caries rates are low. In addition, the risk for caries increases when refined sugar, particularly sucrose, is consumed frequently, more than 4 times a day. Although the use of fluoridated toothpaste has significantly decreased the importance of sugar within the development of dental caries, the daily intake of sugared foods and beverages should not exceed 10%E and sugar should not be consumed more often than four times a day

according to experts from WHO and EURODIET [WHO, 2003a; EURODIET, 2000; AROLA et al., 2009].

A rather new dental disease – mainly of the modern society – is the diet-related dental erosion. It is probably due to high intake of soft drinks and fruit juices nowadays [WHO, 2003a].

Osteoporosis. Dietary and lifestyle factors also play a decisive role in the development of osteoporosis. There is possible evidence that high sodium intake could increase the risk for this nutrition-related disease, especially when calcium intake is low. A high excretion of sodium in the urine due to excessive sodium intake goes along with high excretion of calcium because of the competitive reabsorption in the renal tubule and the salt-induced volume expansion [HEANEY, 2006]. Thereby the metabolism of bone mass can be influenced and bone degradation in postmenopausal women can be enhanced [DACH, 2008]. The amount of sodium present in bones quite superficially (about 50%), is probably only of little importance in the development of osteoporosis [HEANEY, 2006].

A recommended intake of at least 1,000mg calcium per day can diminish the detrimental effects of sodium excess, because the absorption rate of calcium increases and compensates the urinary loss. Moreover, the daily intake of 1,000mg of potassium as recommended (e.g. in form of KHCO_3), can reduce the sodium induced calciuria [HEANEY, 2006]. In order to reduce the risk for osteoporosis, it is recommended to stay active and maintain a healthy body weight as well as to cut down on salt [WHO, 2003a].

2.1.2. The detailed function of sodium, sugar and saturated fatty acids in health

SODIUM. Sodium is essential and the most prominent cation of the extracellular fluid (about 50% of total sodium). Its task in the human body includes the electrolyte and acid-base-balance, homeostasis of total body water and transmembran potential difference. With the active absorption of sodium (Na-K-ATPase) in the gastrointestinal tract other nutrients can be absorbed [DACH, 2008].

There is no official recommendation for minimal sodium intake, but the D-A-CH reference values consider intake estimates (Table 2). The estimated minimal intake requirement for sodium ranges from 100mg/d for neonates up to 550mg for youths and adults (Table 2), whereas reports on populations that survive with daily intakes as

little as 5mg sodium per day suggest even lower physiological needs [DACH, 2008; PENNEY, 2009]. These intake recommendations can easily be covered by dietary sources, in times of additional requirements (pregnancy and lactation) too [DACH, 2008]. There is a probable risk with very low daily intakes (<1g/d) to increase the burden of oxidative stress, elevate LDL and triglycerides levels, raise the blood pressure (in 10-15% of the cases) and to decrease the insulin sensitivity and intake of iodine [GROSSKLAUS et al., 2010]. Concerns about potential harms of low sodium intake are not evident. Only elderly often suffer from hyponatraemia (<135mmol/l), but not as a result from very low sodium intake [DORNER, 2010]. On the contrary, the population in industrialized countries consumes far more sodium than the physiological need, on average about 4g a day [GILBERT and HEISER, 2005]. The majority of adult populations worldwide and most children older than 5 years have mean sodium intakes of more than 2.3g per day – these individuals are generally unaware of the detrimental effects of high sodium intakes on health [BROWN et al., 2009].

Table 2: Estimates for minimal intake requirements and recommendations for the maximum intake

Age	MIN. INTAKE REQUIREMENTS Sodium ¹ (mg/d) [DACH, 2008]	MAX. INTAKE RECOMMENDATION NaCl ¹ (g/d) [SACN, 2003]
0 - <4 months	100 (23mg/kg)	1 ≈ 400mg Na
4 - <12 months	180	1
1 - <4 years	300	2
4 - <7 years	410	3
7 - <10 years	460	5 ≈ 2g Na
10 - <13 years	510	6 ≈ 2.4g Na
13 - <15 years	550	6
>15 years	550 (23mg/100kcal)	6
¹ NaCl (g) ≈ Na (g) x 2.5; 1 mmol Na = 23mg Na Pregnancy: + 70mg/d (↑ extra cellular fluid) Lactation: + 140mg/d (sodium extent in breast milk = 140mg/l)		

An upper level for sodium coming from dietary sources has not been fixed yet: The intake of 0.5 to 1g of NaCl/kg body weight can be toxic and life-threatening for the majority of people. Moreover, very high intakes of sodium can enhance the effect of carcinogens (Na itself is not carcinogenic) and increases the risk for an infection with *Helicobacter Pylori* [EFSA, 2005]. The necessity to limit sodium intake follows from its

significant, undesirable effect on blood pressure: High sodium intake elevates the blood pressure resulting in a higher risk for CVDs, stroke and renal disease especially in elderly and sensitive people with hypertension, obesity, chronic kidney disease or diabetes [BIBBINS et al., 2010; GROSSKLAUS et al., 2010]. Decreasing the sodium intake in children is linked with lower blood pressure in adults and would prevent future cardiovascular events [BROWN et al., 2009] Evidence highlights a daily sodium intake of 1.7g to improve blood pressure significantly without any adverse side effects [GILBERT and HEISER, 2005]. In the US, for example, a reduction of sodium intake by 1.2g (3g NaCl) could prevent up to 120,000 new cases of CHD, 66,000 cases of stroke, 99,000 myocardial infarcts and 92,000 deaths per year – a potential similar to the affectivity of medical treatments and other public health interventions. Moreover, more than 200,000 quality-adjusted life-years and 6 billion € health costs could be saved annually [BIBBINS et al., 2010]. Sodium sources other than NaCl (e.g. sodium nitrate, nitrite, phosphates and glutamate) do not have a significant impact on blood pressure. Not only the absolute amount of sodium chloride but also the sodium-potassium-ratio is important for blood pressure [DACH, 2008].

According to EURODIET and WHO, adults should not consume more than 2-2.5g sodium per day [EURODIET, 2000; WHO, 2003a] and the Scientific Advisory Committee of Nutrition suggests a maximum daily intake of sodium for children (aged 1 to 10 years) ranging from 0.4 to 2g (Table 2) [SACN, 2003]. Persons with high susceptibility for hypertension like obese, elderly and black subjects are strongly recommended to ingest less than 2.5g of sodium [EURODIET, 2000].

The stock of sodium in newborns is around 5.5g, 100g in men and 77g in women and the biggest part of it (1g/kg body weight) is exchangeable. Almost 60g of sodium can be found in the bone mass. The body stock of this cation is actively maintained (99% reabsorbed) and controlled by the system of aldosterone, angiotensin, renin and natriuretic peptide [DACH, 2008]. With high sodium intake, the system of renin and angiotensin is inhibited, the extracellular water increases, the reabsorption rate at the proximal tubule is reduced and sodium is eliminated with rising blood pressure (pressure induced sodium elimination). In sodium resistant individuals sodium excretion is quickly adjusted to high salt intakes. This mechanism seems to be altered in obese persons as their sodium excretion rate is independent of the dietary amount of sodium [GROSSKLAUS et al., 2010; ORTEGA et al., 2010].

Biochemical measures can capture the sodium turnover of the body very well as the principal route of disposal is through urine and only small amounts of sodium are lost

through sweat [LORIA et al., 2001]: Sodium is eliminated via urine ($\approx 25\text{mg}-10\text{g/d}$), stool ($\approx 110\text{mg}-230\text{mg/d}$) and the skin ($\approx 45\text{mg}-2\text{g/d}$, sweat about 500mg/l except for cystic fibrosis) [EFSA, 2005; DACH, 2008]. The golden standard for the assessment of sodium intake is the 24h-urinary excretion. The accurate estimation of sodium intakes from other dietary assessment methods like FFQs or recalls is impeded due to underestimation of the sodium content of foods and the amount of salt added at home by subjects [ORTEGA et al., 2010].

The urinary sodium excretion can significantly fluctuate depending on the intake level from 0 to 25g (excessive intake): In Europe, about 70-75% of ingested sodium is coming from sodium chloride added to processed foods, compared to 10-15% arising from natural sources (fruits: $0.2\text{g}/100\text{g}$ – meat, fish, eggs: $70\text{g}/100\text{g}$) and 10-15% being added at home during cooking or at the table. The EU guiding value for drinking water is 20mg Na/l (EG critical value 200mg Na/l) [EFSA, 2005]. The main sources of sodium, accounting for about half of the intake in Europe, are cereal products including breakfast cereals, bread etc (28-38% of sodium intake) with mean contents of $200\text{mg Na}/100\text{g}$, meat products (mean: $840\text{mg Na}/100\text{g}$, accounting for 10-20% of sodium intake) and cheese contributing about 11% to the daily sodium intake. The food group that is highest in sodium is sauces and spreads ($1,300\text{mg}/100\text{g}$) [BROWN et al., 2009; WEBSTER et al., 2009; FND, 2010].

In former times, salt was used as a means of preservation, a function that can be neglected since the invention of the refrigerator in the 20th century [BROWN et al., 2009]. Nowadays, the use of sodium in foods leads to extended shelf-life, restricted growth of undesired micro-organisms and enhances the taste and flavour of foods, moreover sodium influences the consistence of dough and the water content in meat products, but evidence suggests that the high amount currently used by food enterprises could be reduced considerably [GILBERT and HEISER, 2005].

At the moment, very low or low sodium diets ($0.4\text{g Na}/1.2\text{g Na}$ per diet) are hardly possible to maintain over long time without guidance considering these environmental aspects. Even a moderate sodium diet (max. 2g Na) is challenging for patients who should reduce their salt intake because of the wide distribution throughout the range of foods. In view of the availability of foods high in sodium, the achievable recommendation is about 2.3g of sodium per day [DACH, 2008; LICHTENSTEIN et al., 2006]. In countries with high salt intakes due to processed foods, primary hypertension is more prevalent and product reformulation could be very effective as can be seen from the successful reduction strategies in the UK and Finland. In only 4 years, the salt

intake in the UK has fallen by almost 10% due to the Consensus Action on Salt and Health and food reformulation without significant reduction in consumer acceptance and product sales. Another pioneer in salt reduction, Finland, could significantly reduce the average salt content of processed foods due to an aggregation of regulative, educational and labelling strategies including a punitive high salt warning label. In Finland, many companies just removed their products from the market instead of having to put a “high salt” label on them [PENNEY, 2009; BIBBINS et al., 2010]. The salt intake in Finland has been reduced by about 30% resulting in a fall of blood pressure (>10mmHg systolic and diastolic) and a decrease in stroke and heart disease of 80% [HE et al., 2008].

Several double-blind studies have approved the high level of evidence for positive effects of sodium reduction [EURODIET, 2000]. Although the individual effect of sodium reduction in hypertensive patients at high risk like elderly, obese and black persons might be bigger, a smaller but population wide reduction in blood pressure will bring much more benefit and prevent more cases of CVDs, than just treating the number of patients with hypertension as indicated by the so-called “Rose hypothesis” [NHS, 2010].

SUGAR. In Europe, many different terms are used when talking about “sugars”: single sugars, added and free sugars, intrinsic or extrinsic sugar as well as total sugars. In the legislation for labelling purposes, the term “sugar” is used for all mono- and disaccharides in a food. The expression “Intrinsic sugars” comprises all natural kinds of sugar (e.g. from fruits, cereals or milk) [PALOU et al., 2009]. According to the WHO, the term “free sugars” includes mono- and disaccharides and sugars from honey, syrups or fruit juices that are added to foods by manufacturers, cooks or consumers – similar to the meaning of “added sugars” [WHO, 2003a]. Total sugars include both intrinsic sugars and added sugars [EFSA, 2009].

Within the human body, carbohydrates are mainly converted to glucose (major fuel for cells and brain tissue) and oxidised or saved as glycogen [MARDIS, 2001]. Adults use about 180g of glucose per day. In order to avoid gluconeogenesis from protein and lipolysis, the minimal intake of carbohydrates for adults and children should be at least 25%E. With excessive intake of carbohydrates (>400-500g/d) synthesis of fatty acids is stimulated [DACH, 2008].

The role of sugars in human nutrition and health is a controversial matter in nutritional sciences. Evidence suggests that high intake of monosaccharides might

increase the risk for pancreatic cancer (potential evidence) and sugared drinks probably raise the risk for diabetes mellitus [HAUNER et al., 2011]. Moreover, excessive ingestion of refined carbohydrates increases the lipid triglyceride level in blood [DACH, 2008]. The evidence for adverse effects of sugar intake on the incidence of insulin resistance and diabetes mellitus or hyperactivity is insufficient. Inconsistent associations between daily intake of sugar and micronutrients do not confirm the hypothesis of sugar-related micronutrient dilution [AROLA et al., 2009]. High proportions of sugar (up to 16%E) in the diet do not necessarily result in an overall poor quality diet. Only with intakes of added sugars greater than 18%E, the intake for many micronutrients is below the recommended daily allowance (RDA) [MARDIS, 2001; WILLIAMS, 2001].

Free sugars are so called “empty calories” that provide plenty of energy without containing any specific nutrients and contribute significantly to energy dense diets and therefore, the lower intake limit is equal to zero [MARDIS, 2001; WHO, 1998]. The intake of disaccharides (mainly sucrose = *alpha-Glc(1-2)beta-Fru* and lactose = *beta-Gal(1-4)Glc*) accounts for 9-19%E and monosaccharides (mainly glucose, fructose and galactose) contribute 5-8% to the total energy intake. The proportion of sucrose added to foods is about 6-13% of total energy. More than half of the total intake of disaccharides is due to added sugar [DACH, 2008]. About 45g of intrinsic sugars derive from the recommended intake of 400g fruits and vegetables (28g) and three portions of milk products (accounting for 17g sugar) a day. In addition to this amount, not more than 45g (about 9-10%E) should come from added sugars in order to achieve the labelling reference intake of 90g sugar per day [EFSA, 2009].

Sugared foods and beverages should be consumed only moderately, especially when seeking a reduction in weight [DACH, 2008]. The level of evidence on greater weight loss due to an exchange of refined sugar for more complex carbohydrates is insufficient [AROLA et al., 2009]. But free sugars, especially from sugared drinks (including juices and nectars), increase the risk for excessive energy intake and positive energy balance due to lacking appetite control and satiety and therefore the risk for unhealthy weight gain and obesity especially in children and adolescents [WHO, 2003a; AROLA et al., 2009]

As evidence is often insufficient and the role of sugar in human health is still discussed controversially, most scientific recommendations do no longer comprise all sugars but focus on giving advice on the intake of added or free sugar [WILLIAMS, 2001]: WHO and FAO invented a population nutrient intake goal of 10%E from free

sugars and experts from EURODIET recommend consuming sugared foods and beverages less than 4 times a day [WHO, 2003a; EURODIET, 2000].

SFAs. Saturated fatty acids (SFAs) provide on average 9kcal/g like all other fats. The food industry appreciates SFAs because of their melting characteristics (melting point at high temperature) and crystallisation properties. SFAs are not considered as essential nutrients in the human diet, because all mammals are able to synthesise SFAs, therefore the lower intake limit is equal to zero [WHO, 1998; MASON et al., 2009]. Although saturated fatty acids could be produced endogenously via lipacidogenesis of glucose, these fatty acids are mainly ingested with the diet [DACH, 2008]. Palmitic (C16:0) and stearic acid (C18:0) are the most prevalent saturated fatty acids in the European diet and account for about 70% of SFA intakes, mainly due to the frequent consumption of dairy and meat products. Milk and milk products (including butter) as well as meat and meat products contribute considerable amounts of SFAs to the average daily intake, 30% and 22% respectively. Smaller amounts are attributable to fats of plant origin like cocoa butter and coconut or palm oil [MASON et al., 2009].

The evidence on adverse effects of SFAs on diabetes and obesity is inconsistent and although excessive intake of animal fat increases the risk for colorectal cancer, there is little evidence whether SFAs are to blame. On the contrary, evidence suggests a significant, positive association of SFA intake with the risk for CVDs. Dietary SFAs promote diverse CVD-risk-factors including high blood cholesterol levels, endothelial dysfunction, inflammation and hypertension and raise the amount of triglycerides in blood [MASON et al., 2009]. The long-chain SFAs Lauric- (C12:0), Myristic (C14:0) and Palmitic acid increase the serum level of total and low density lipoprotein-cholesterol (LDL) and therefore the risk for coronary heart disease. Stearic acid on the other hand has no significant influence on the LDL cholesterol concentration (inconsistent results). Animal products from ruminants like milk or butter contain a considerable amount of short chain SFAs resulting from bacterial fermentation and are also prevalent in the human diet. But different to long-chain SFAs, short and medium chain fatty acids have no evident, adverse effect on the serum cholesterol level [DACH, 2008; MASON et al., 2009].

In order to prevent CVDs, a reduction of population wide SFA consumption is indispensable and scientific experts recommend not ingesting more than 10%E from SFAs [WHO, 2003a]: Already 1% decrease of plasma cholesterol reduces the risk for coronary heart disease by about 2% [MASON et al., 2009]. Reducing the general

consumption from actual intakes by half to about 6-7%E could save 30.000 lives due to avoidance of cardiovascular events [NHS, 2010]. The American Heart Association therefore recommends limiting the daily intake <7%E from SFAs as a population wide goal [LICHTENSTEIN et al., 2006]. Finland, Poland and the UK are examples for successful interventions concerning the intake of saturated fat followed by a significant fall in CVDs: A combination of Finnish nutrition guidelines, campaigns and reformulation strategies made it possible to reduce the total SFA consumption by half (from 21%E to about 12%) in about 20 years. In line with the daily SFA intake, the mortality from CVDs in Finland decreased by 65%. In Poland the incidence of cardiovascular events decreased due to dietary changes including a decrease of 7%E from SFAs [MASON et al., 2009].

In the prevention of CVDs, the modification of the type of fat (qualitative aspect) is more important than reducing the quantity of fat: If SFAs are replaced by monounsaturated fatty acids (MUFAs), the amount of LDL is only passively reduced due to the removal of the SFA induced rising effect. Nevertheless, this replacement could reduce about 30% of myocardial infarcts. An exchange of SFAs for polyunsaturated fatty acids (PUFAs) is most efficient (45% reduction in myocardial infarcts) as PUFAs can actively reduce LDL cholesterol. On the contrary, the replacement of 5%E from SFAs with carbohydrates has the least lowering effect on total and LDL-cholesterol compared with MUFAs and PUFAs, but still could reduce about 15% of myocardial infarcts [DACH, 2008; MASON et al., 2009]. The food sector could help to reduce the SFA intake on population level through reformulation processes and provision of healthier options [MASON et al., 2009].

2.2. Existing prevention strategies to improve the diet quality

With regard to public health, the first step to improve the diet quality in Europe was to decide on rules and common principles regulating hygienic requirements and responsibilities of the food producing and preparing sector. The science-based principles of the so-called “Hazard analysis and critical control points” (HACCP) should guarantee (micro)biological, chemical and physical safety and suitability of foods at any stage of the food chain from primary production to the consumption and thereby reduce the risk for food borne illness. The HACCP system comprises seven standardized steps fixed by the Codex Alimentarius Commission (Table 3) [EC, 2004].

Table 3: HACCP principles [EC, 2004]

HACCP PRINCIPLES: 7 steps to (micro)biological, chemical and physiological safety of food	
1)	CONDUCT A HAZARD ANALYSIS: Identification of any hazards that must be prevented, eliminated or reduced to acceptable levels (microbiological, chemical and physical aspects)
2)	DETERMINE THE CRITICAL CONTROL POINTS (CCP): Identification of the critical control points at all steps at which control is essential to prevent, eliminate or reduce a hazard
3)	INSTALL CRITICAL LIMITS: Establishment of critical limits at CCPs to separate acceptability from unacceptability
4)	CREATE A SYSTEM TO MONITOR: Establishment and implementation of effective monitoring procedures for the control of the CCP
5)	CORRECTIVE ACTIONS: Establishment of corrective actions when indicated by monitoring
6)	VERIFICATION PROCEDURES: Establishment of regular procedures for verification to confirm that the HACCP system (esp. points 1-5) is working effectively
7)	DOCUMENTATION: Establishment of documentation and records concerning all procedures to demonstrate the effective application of these measures

Since April 2004, the HACCP system is regulated by law (EC N°852/2004 of the European Parliament and Council) and since 2006 food enterprises in all European member states have to exhibit a working HACCP concept [EC, 2004].

The improvement of foods and diet quality should not only comprise strategies to ensure food security (e.g. HACCP), but should also be directed at guaranteeing an adequate food supply with healthy, qualitative foods and changing or modifying the social and health environment in Europe.

Different approaches exist to deal with the burden of NCDs targeted on a reduction of the nutrients as risk factors. Interventions that seek to improve individual behaviour are important, but strategies focusing on the population-level could lead to further benefits: *Dietary guidelines* have been developed recommending concrete intake levels for fat (<30%E), SFAs (<10%E), sodium as sodium chloride (<5-6g/d) and sugar with <10% of total energy intake (Table 4) in order to tackle the major public health concerns in Europe [EURODIET, 2000; WHO, 2003a].

Science-based dietary guidelines only seem to have little effect in modifying the diet quality of the European population. Without additional food-based information, these guidelines are unlikely to succeed [ANDERSON and ZLOTKIN, 2000] and nutrition research will not improve people's health without influencing consumption patterns [TRUSWELL, 1998].

Table 4: Population nutrient intake goals for preventing diet-related chronic diseases

WHO Guidelines [WHO, 2003a]		EURODIET Guidelines [EURODIET, 2000]	
Total fat [%E]	15-30	Total fat [%E]	<30
SFAs [%E]	<10	SFAs [%E]	<10
Sodium chloride (Na) [g/d]	<5 (<2)	Sodium chloride (Na) [g/d]	<6 (<2.4)
Added sugars [%E] (+honey, syrups, fruit juices)	<10	Sugar	<4 times/d

As consumers seem to have problems with the implementation of those recommendations in daily life, more specific and comprehensive dietary guidelines – food-based dietary guidelines – were designed to make it easier to adhere to dietary reference intakes. Adherence to those scientific-based dietary guidelines can result in reduced risk for chronic NCDs: In 2002, the US Department of Agriculture demonstrated that people with a high “Alternative Healthy Eating Index” that were closely following the Dietary Guidelines for Americans and the Food Guide Pyramid could significantly reduce the overall risk for chronic diseases by 20% in men (RR = 0.80; 95% CI: 0.71, 0.91; P<0.001) and 11% in women (RR = 0.89; 95% CI: 0.82, 0.96; P<0.01). The highest reduction could be observed in cardiovascular diseases: Men and women with the healthiest food choices could lower their risk for CVDs by 39% and 28% [McCULLOUGH et al., 2002].

Nevertheless, difficulties still exist when it comes to the “hidden content” of these nutrients especially in processed foods and dishes: E.g. about 75% of the salt intake is coming from processed foods [FSA, 2005; PENNEY, 2009]. All European ready meals, analyzed in the course of the project “Double Fresh”, contained more than the recommended amount of salt (>720mg sodium/serving) and some even exceeded the recommended daily intake of 6g (2.4g sodium). In 16 out of 34 dishes the amount of SFAs exceeded 10%E, ranging up to 22.3%E [KANZLER and WAGNER, 2009].

As the food industry and HORECA sector take over the role of food preparation and people consuming a considerable amount of meals outside home, consumers are less aware of the ingredients and nutritive value of foods. The confusion is likely to increase as several fat- or sugar replacement technologies simulating the correlating taste separate sensory properties from the perceived nutrient composition. With the increase of the so-called “food illiteracy” – that is the lack of basic nutritional

knowledge and cooking skills in the modern society, there is often a discrepancy between perceived and actual intake of disease-related nutrients [WISEMAN, 1994]: Many adults avoid salting their food at the table (about 20% use it only rarely or occasionally) and think that their sodium intake is within the recommended level. Nevertheless, due to unawareness of the “hidden salt”, most people are unable to judge whether their daily salt intake is in line with the guidelines. In the study NHANESIII more than half of the subjects believing their intake conforms to recommendations, had daily intakes of sodium >2.4g [LORIA et al., 2001].

Due to the global economic wealth, dietary trends worldwide shift towards overconsumption of monosaccharides and saturated fats, a fact that is called “nutrition transition” [DREWNOWSKI, 2000]. In 2030, the WHO predicts that the daily per capita food consumption in industrialized countries will amount to 3,500kcal with plenty of energy coming from fat, especially saturated fat (e.g. meat consumption will rise to 100kg per year) and sugar [WHO, 2003a]. More than 50% of the energy intake in Europe and North America are derived from fat and sugar [WHO, 2002].

Individual-based education approaches including direct encouragement to change the nutrition transition and the individual behaviour is difficult. In order to improve the diet quality among a large number of people, it is more important to focus on population-wide strategies and environmental changes including social, economic and material factors [NHS, 2010]. Communities, health care systems and leisure and food industries have to cooperate in order to stop or at least slow down the nutrition transition and actual evolution towards an obese society suffering from chronic NCDs with easy access to plenty of unhealthy, cheap and energy-dense foods. According to a WHO Study Group in 1990, the world’s leading food enterprises would easily be able to change the “obesogenic” environment and produce healthy, nutritious foods or at least healthier options, but their interest in promoting tasty, high-fat and sugary products and making profit minimizes the success of attempts and approaches towards a healthy society [DREWNOWSKI, 2000; WHO, 2003a].

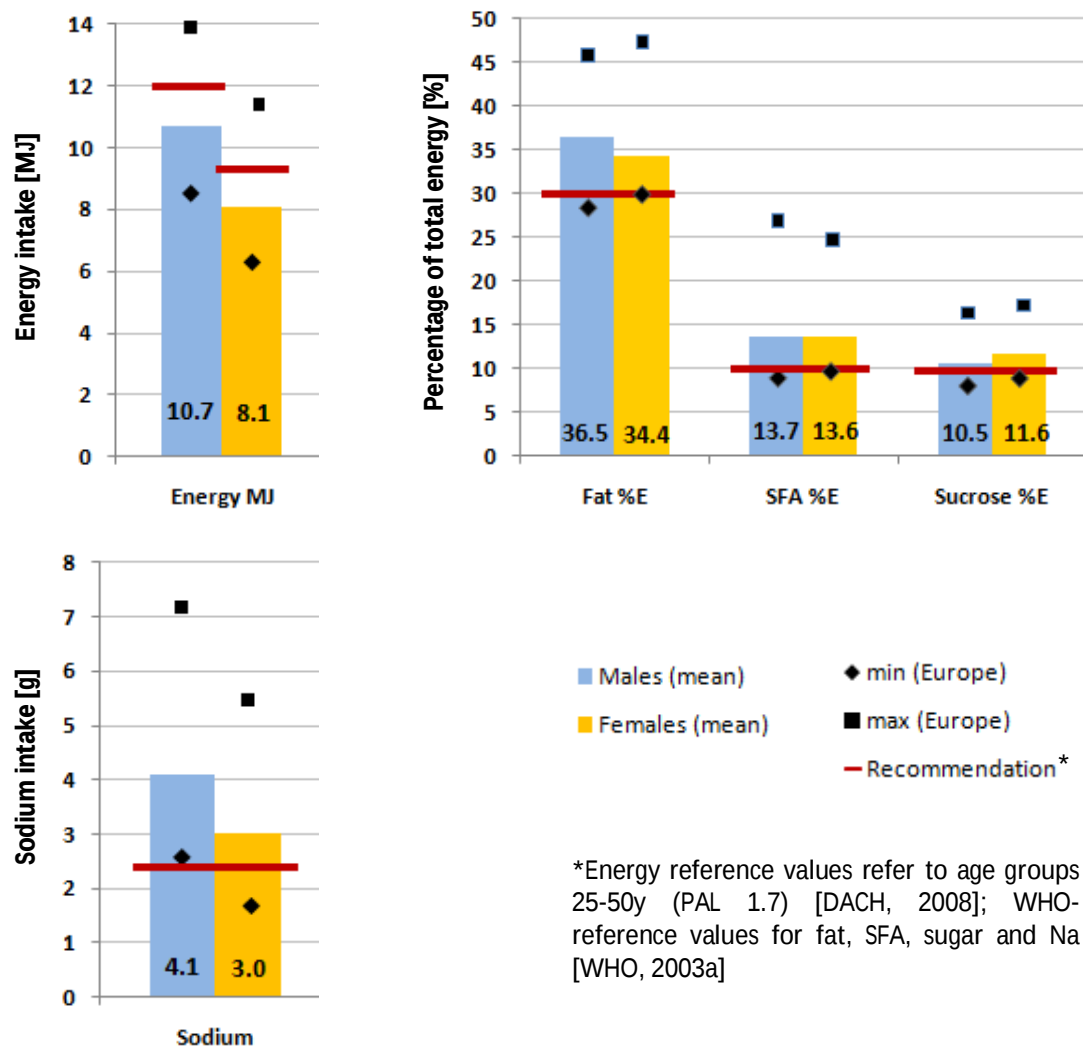
Big food companies reacted by starting to evaluate their foods and beverages for their nutritional quality and developed independent nutrient profiling systems. Calculated scores like the *Nutrition Score* with benchmarks for SFAs, total and added sugar as well as sodium [NIJMAN et al., 2007] or indices that combine beneficial nutrients and nutrients to limit (like Nutritional Quality Index, Nutritious Food Index, Nutrient Density Scores, FSA models etc.) should enable to analyze the nutritional

quality of foods. Marking systems like the well-known *Traffic light labelling* in the United Kingdom that highlights the content of fat, SFAs, sugar and sodium as salt with different colours according to the quantity of the nutrients [FSA, 2010] or the *Swedish Keyhole mark* aiming to reduce the prevalence of coronary heart disease [REUTERSWÄRD, 2007] should help the consumer to make the healthier choice the easiest one and serve as incentives for the food sector to ameliorate the composition of products and dishes in order to get positive “marks” [LOBSTEIN and DAVIES, 2008]. The front-of-pack signalling can help consumers to improve the individual diet quality requiring only little nutritional knowledge. Nevertheless, the availability of plenty of foods high in sodium, sugar and SFAs hinder individuals to catch up with the guidelines for daily intakes [LOBSTEIN and DAVIES, 2008].

Several strategies have been adopted in Europe to take on the burden of diet-related chronic diseases, but – despite diverse recommendations and actions – the intake of the nutrients sodium, saturated fatty acids and sugar is still too high in most European countries. In 2004, the consumption of SFAs in Europe exceeded the maximum limit of 10% of the total energy of the diet by about 40%. In case of sodium (<2.4g sodium/day) there was an excess of around 33% in the European diet and sucrose intakes exceeded the maximum recommendation of 10%E coming from free sugars by 21% [RMHCB, 2010a; ELMADFA et al., 2005].

In 2009, the average daily sucrose intakes in central and Eastern Europe reached almost 50g/capita with Germany and Poland reporting the highest values (45 and 57g respectively), whereas in Italy, representing the south of Europe, the amount of sucrose made up only 20g/capita/day. The average intake of sucrose in Europe contributed 11%E to the total energy intake. The share of fatty acids was generally not in line with actual recommendations too, especially SFAs accounting for 13.7%E were well above the recommended level of 10%E. Whereas the Romanian population still had a very high intake of SFAs (about 26%E in adults), other European countries had daily intakes quite close to the average. In case of the sodium, especially Hungary, Poland and Italy reported excessive intake levels of more than 5g sodium per day (7.3, 6.0 and 5.8g, respectively). In average, the European population had intakes of 3.6g sodium (9g NaCl) per day (Fig.1) [ELMADFA et al., 2009].

Fig. 1: Intake of energy and disease-related nutrients in Europe based on various national data [ELMADFA et al., 2009]



Since 1960, the intakes of the disease-related nutrients continuously converge across the EU and diets become more homogeneous. The importance of geographic proximity in the similarity of food consumption aspects has decreased, instead globalization leads to convergence processes within all European countries: Whereas several countries with excessive intakes of SFAs (e.g. Finland), salt or sugar were able to reduce the average consumption close to the maximum recommendation, others that started from a healthy level gradually close the gap on the other European countries (e.g. Spain and Greece) [SCHMIDHUBER and TRAILL, 2006].

This excess of the “risky nutrients” is mainly due to few sources in the diet (Table 5). The main contributors of total sodium consumption are cereals and cereal products including bread (in the UK accounting for 35% or 2.3g/d), meat and meat products

(26% or 1.7g/d) and cheese amounting for about 3% of sodium intake, whereas especially individual composite foods or salted snacks can contain a great deal of sodium [EFSA, 2005].

Table 5: Main sources of the disease-related nutrients and most popular, existing reformulation strategies [LÜFTENEGGER and ELMADFA, 2009]

Nutrient	Main sources	Technological aspects	Strategies
<i>Sodium (Salt)</i>	Bakery Meat prod. Cheese Vegetable prod.	texture, yeast moisture, binding capacities aroma, texture, microbial growth fermentation, texture	Herbs or salt surrogates as substitutes
<i>Sugar</i>	Desserts/sweets Cereal prod. Milk/milk prod. Soft-drinks	sweetness, product spread, colour, eating quality	Mix of poly-dextrose, fructooligosaccharides, sweeteners or natural sweeteners as substitutes
<i>SFAs</i>	Meat/meat prod. Milk/milk prod. Desserts/sweets Cereal prod. Snacks	thickening agent, bulking agent, smoothness, succulence	Change the type of fat, use of reduced-fat versions, use of fat replacers (suspension of fibres, hydrocolloids, carageenan, pectin etc.)

Sugar sweetened drinks including fruit juices and sweets, grain and dairy desserts are the main sources of free sugar in the diet of children in western countries, whereas more than 50% of added sugars arise from beverages [BACHMANN et al., 2002; REEDY and KREBS-SMITH, 2010; ELMADFA et al., 2009]. In those drinking plenty of soft drinks, fruit juices and syrups (four times as much as in the group with recommended sugar intake), the amount of added sugar accounted for $\geq 15\%$ [ELMADFA et al., 2009]. Milk and milk products (including butter) as well as meat and meat products contribute considerable amounts of SFAs to the average daily intake, 30% and 22% respectively [MASON et al., 2009]. In children the top sources of SFAs are mainly pizza, dairy and grain-based desserts, cheese and processed meat (like sausages or bacon) [BACHMANN et al., 2002; REEDY and KREBS-SMITH, 2010]. In general, all processed foods account for the lion's share in sodium, sugar and SFA intake and add up together

with all foods consumed in take-aways and other outlets to a significant contribution to the excess in these nutrients in the diet of many people [NHS, 2010].

Therefore, the food sector, especially the food industry, has often been blamed for contributing to the obesogenic and unhealthy environment in the modern society. One of the major challenges this sector has to face nowadays is the pandemic increase of nutrition-related diseases and the resulting demand to shift the production concepts towards safe, tasteful and healthy foods: In times of growing tendency for “away-from-home-eating” and convenience food, the food industry and catering sector could significantly stimulate healthy nutrition by changes in production processes, pricing and marketing strategies as well as labelling initiatives and ameliorate the individual nutrient intake without costumers even noticing [EURODIET, 2000].

Manufacturers, especially of big companies, become increasingly aware of this problem and are willing to develop solutions to reduce the levels of “risky nutrients”. They start to change the formulation of their recipes and products in order to adapt to the consumers’ needs and expectations [CIAA, 2010].

Compared with other prevention strategies of nutrition-related NCDs, the benefits of nutritional improvement over a wide range of basic, commonly eaten foods could already be expected in the shorter term, as the individual behaviour does not have to be altered and people can continue to eat their preferred products and dishes [VAN RAAIJ et al., 2008; MASON et al., 2009].

The key nutrients for the modification of the nutrient content – the reformulation of a food – are saturated fatty acids, added sugars (in order to strengthen the benefits of fruit, vegetables and milk as potential source of sugar) and sodium as salt [LÜFTENEGGER and ELMADFA, 2009]. Sugar, salt and SFAs fulfil several functions in foods and are therefore appreciated by the food industry (Table 5): E.g. besides sweetness, sugar also affects the colour, texture and eating quality of the food. Thus, the modification of ingredients turns out to be very challenging sometimes due to complex interactions between raw materials and often requires several attempts until a viable, healthy product or dish is created [BOOBIER et al., 2006].

Modification of breeding techniques and animal feed can improve the composition of basic products at the level of primary production: E.g. addition of linseed oil to the forage of cows resulted in a 20% higher proportion of unsaturated fatty acids in milk. Improvement of basic products would lead to healthier final products and dishes when used as ingredients [VAN RAAIJ et al., 2008]. To adjust soft drinks for pH, texture or

flavour was found to help reducing the amount of sugar without adding sweeteners [FDF, 2009] and in biscuits the best results could be achieved with a mix of polydextrose and fructo-oligosaccharides [BOOBIER et al., 2006]. Examples for successful and palatable fat reformulations are reduced-fat (skimmed) milk and yogurts. Versions that are often considered less tasty, but could also successfully establish on the market include margarine, vegetable (frying-)oils and products [TRUSWELL, 1998]. A summary of the most popular, existing reformulation strategies can be found in table 5. Considering the cumulative effect of small amounts of an undesirable nutrient across a wide range of foods, even small changes could contribute to an overall better diet [LÜFTENEGGER and ELMADFA, 2009].

According to the WHO supported by the findings of several prevention strategies, a modification of the environment in which nutrition-related chronic diseases develop including reformulation of production concepts, is indispensable when planning long-lasting interventions. Moreover, it is necessary that not only health professionals but also the food industry, politicians and communities actively take part in the realization of those changes: By means of media and intensified communication strategies together with health professionals, consumer awareness can be raised. The food sector can provide healthier options by reformulation of food products and dishes. And the governmental engagement together with the community level could include labelling strategies, pricing policies (taxes or subsidies), research funding and if necessary introduction of laws and provisions [WHO, 2003a].

Therefore, the pilot project “FOOD PRO-FIT” (2006 340) [PHEA, 2007] involved companies, health professionals and researchers and combined the most promising parts of existing strategies (guidelines, profiling and reformulation) in a new, innovative, global approach to improve the nutritional quality of produced or processed food by reducing the amount of these disease-related nutrients.

3. METHODS AND EXPERIMENTAL PROCEDURES

3.1. FOOD PRO-FIT

The pilot project “HANCP as a public health indicator for the value chain of food production processes” (2006 340) with the acronym “FOOD PRO-FIT” received funding from the European Commission in the framework of the Public Health Program [PHEA, 2007]. From November 2007 to December 2010 companies, health professionals and researchers of seven European countries worked together on a strategy to improve the diet quality in Europe: Spain (Project coordinator: Regional Ministry of Health of the Balearic Islands), Austria (Institute of Nutritional Sciences of the University of Vienna), Cyprus (Ministry of Health of Cyprus), Germany (European Business Centre LTD), Greece (Region of Crete), Poland (Institute of European Initiatives) and Slovakia (Agency for the Support of Regional Development). The Institute of Nutritional Sciences was thereby especially entrusted with the tasks “scientific guidance” and “evaluation of the project”.

Fig. 2: Project logo
[PHEA, 2007]



The project “FOOD PRO-FIT” comprised the following three aspects for successful programmes preventing chronic NCDs [PENNEY, 2009]:

- *Environmental changes* to make the healthier choice the easiest choice
- *Assessing consumer knowledge and perceptions and creating awareness-raising campaigns and strategies*
- *Product reformulation*: Identification of main sources for desired nutrients, recruiting of manufacturers, decision on clear monitoring strategies and the creation of a tool to assist SMEs in the reformulation

In order to improve the diet quality and the quality of foods, “FOOD PRO-FIT” focused on the reformulation of food production concepts: The existing quality-management system HACCP was extended by including nutritional criteria or nutritional control points (NCPs) into the value chain of food production and preparation. The result is the so-called HANCP (Hazard Analysis and Nutritional Control Points) [PHEA, 2007]. An HANCP-computer application enables small and medium sized enterprises (SMEs) to control and reduce the amount of the disease-related nutrients Na, SFAs and added sugar.

3.1.1. ENVIRONMENTAL SCAN

An environmental scan in form of literature search was done on current intake of the desired nutrients at the baseline. Moreover, primary sources of sodium, sugar and SFAs were identified and it was decided on appropriate targets for reduction. The baseline measurements moreover included the analysis of the awareness level of consumers, administrations and economic operators regarding obesity. Moreover, the degree of commitment of SMEs with healthy diets as well as the importance of improving nutritional characteristics of foods and food habits was captured. Finally, existing control procedures and regulations on food quality and safety were recorded.

Awareness and commitment of consumers and producers

In the first phase of the project a preliminary study on the current situation was carried out in order to identify consumer habits and the commitment of SMEs regarding food nutritional characteristics. Questionnaires translated into the national languages were distributed among enterprises, food producers and consumers in the seven partner countries via email or on-site to make a rough estimate on the knowledge level in terms of nutritional values, healthy diets and food quality (Table 6 and 7).

Table 6: *Number of consumer questionnaires*

	Balearic Islands	Germany	Cyprus	Crete	Slovakia	Poland	Austria	Total
sent	340	300	100	158	300	250	369	1,817
received	338	300	76	158	270	200	317	1,659 (91.3%)

Table 7: *Number of questionnaires from food producers and providers*

	Balearic Islands	Germany	Cyprus	Crete	Slovakia	Poland	Austria	Total
sent	34	> 60	12	15	15	12	17	165
received	34	37	12	15	15	7	15	135 (81.8%)

Due to incomplete or falsely filled questionnaires only 1,410 consumer (77.6%) and 121 SME questionnaires (73.3%) could be considered in this dissertation.

As a result of translations from English to national languages and back, some loss of precision of the answers might have occurred. The results from the questionnaires offer insights into the awareness and opinions of the respondents but might not be fully projectable to larger populations. The majority of questions were closed questions providing nominal data, therefore the statistics used in this dissertation focus on descriptive statistics.

In addition to the preliminary study, focus groups conducted in Austria, Slovakia and Poland were used to discuss some of the results in detail and get further information on the awareness of SMEs and consumers concerning nutritional topics (Table 8). Fixed question and discussion points permitted comparable results from the different focus groups in the three countries including 27 SMEs, 30 HORECAs and 36 consumers. It was very difficult to find interested people to participate in the focus groups. In addition to the meetings, a questionnaire for each group was developed and sent to those who could not participate in the focus groups. The answers were translated into English. Similar or identical responses were correspondingly summarized and grouped into larger categories of similar concepts and perceptions in order to simplify the presentation. Although it is not possible to do statistical generalizations based on these qualitative data, a concrete idea was given on the comprehension of health issues.

Table 8: List of conducted focus groups

INDUSTRY	HORECA	CONSUMERS
Austria: 30.03.09 (11 participants) Poland: 9.03.09 (10 participants) Slovakia: 1.4.09 (6 participants)	Austria: 24.03.09 (8 participants) Slovakia: 23.4.09 (17 participants) Poland: 9.03.09 (5 participants)	Austria (no active participation): 16 questionnaires Slovakia (25.3.09): 20 participants
27 food producers	30 HORECAs	36 consumers

3.2. The HANCP concept and its implementation

A strategy to improve the diet quality should comprise all stages of food production, beginning with the primary production or purchase including the best food choice and ending with the consumption of the product or dish. Along the lines of existing food safety systems, “critical control points” should be identified to reduce or eliminate all nutritional hazards. Therefore, in order to develop healthier food products and to enable self-control in the value chain of food production, transformation and service

processes, “nutritional control points” were fixed by the project consortium and included in the quality-management system HACCP, resulting in the so-called “Hazard analysis and nutritional control points” (HANCP) [PHEA, 2007].

Following the HACCP principles, the HANCP concept comprises seven steps to improve the quality of foods (Table 9): While the HACCP concept focuses on the identification, evaluation and control of (micro-)biological, chemical and physical food safety risks that could potentially harm the consumer and cause foodborne illnesses, HANCP aims to improve the diet quality and minimize the risk for diet-related chronic NCDs [EC, 2004; WHO, 2003b; PHEA, 2007]. Like the HACCP system, HANCP comprises the control of food hazards including trainings of the personnel, controlling, monitoring and evaluation procedures – the focus lies on prevention of potential harms rather than just testing the end-product and assessing its suitability.

Table 9: Comparison of HACCP and HANCP principles

	HACCP PRINCIPLES [EC, 2004]	HANCP PRINCIPLES [RMHCB, 2010a; EBC.Ltd, 2010]
1	HAZARD ANALYSIS of (micro-)biological, chemical and physical aspects	HAZARD ANALYSIS of nutritional aspects (SFAs, sugar and sodium) Nutritional risks are added to the physical, biological and chemical hazards in order to extend the HACCP concept to HANCP. An individual “Error Mode and Effect Analysis” is performed taking into account the nutrients SFAs, added sugar and Na.
2	IDENTIFICATION OF THE CRITICAL CONTROL POINTS (CCP)	IDENTIFICATION OF THE NUTRITIONAL CONTROL POINTS (NCP) This step includes the identification of the nutritional risk or nutritional control points during all phases of the value chain: The so-called Workplace Nutritional Risk Assessment and Control (WONRAC) ensures to capture all sources of the risk, at the moment nutrients are added or altered by cooking processes.
3	ESTABLISHING CRITICAL LIMITS to separate acceptability from unacceptability	CRITICAL LIMITS OR FOOD NUTRITIONAL OBJECTIVES The food nutritional objectives (FNOs) determine the maximum acceptable concentration of a nutritional risk in the final food at the moment of consumption. In addition, nutritional performance criteria (NPC) define the necessary level of reduction according to the HANCP concept.

4	MONITORING SYSTEM for the control of the CCP	MONITORING VIA HANCP COMPUTER APPLICATION In order to assess the nutritional risk and the level of FNOs and NPCs and to monitor changes in the recipe, specific nutritional operational programs following the requirements of the HACCP concept (including the HANCP computer application) have to be established and implemented in the production process.
5	CORRECTIVE ACTIONS when indicated by monitoring	CORRECTIVE ACTIONS OR REFORMULATION If a food exceeds the limits fixed by the consortium (indicated by HANCP tool), corrective actions including reformulation of the recipes and food production concepts have to be taken. Possible technological or sensory consequences as well as food safety and durability have to be considered (HACCP).
6	VERIFICATION PROCEDURES to confirm the efficiency of the system	VERIFICATION AND QUALITY INSURANCE In order to confirm the accuracy of the HANCP tool and the correct handling, training sessions, audits (including random sampling and analysis) and evaluation processes are to be incorporated in the process: All responsible staff has to be trained by HANCP experts. The level of compliance with the reformulated recipe has to be monitored. Audits and accompanying process control including sensory and microbiological sampling and durability tests will ensure efficiency of the HANCP system and observation of HACCP principles. The evaluation of customer acceptance confirms the successful reformulation of products and dishes.
7	DOCUMENTATION to demonstrate the effective application	DOCUMENTATION Documentation strategies include reports on every step of HANCP and follow the requirements of the HACCP concept. After a successful reformulation enterprises can get a certificate with the results of HANCP risk evaluation that is valid for six months and documents the results of the SMEs.

But it is important that the 7-principle scheme of HACCP always stays the premise before applying the additional nutrition aspects: Prior to the application of HANCP, the enterprise must possess a working HACCP system, good hygienic practices and appropriate food safety requirements. Only with the combination of the two concepts, consumer confidence in food products could be increased and high quality products could be offered.

The next step was to create the application to allow enterprises to evaluate the individual risk and to propose opportunities to improve their dishes and products.

3.2.1. Draft of the HANCP tool

The draft of the HANCP tool to support SMEs in changing the key nutrients in food products was developed stepwise following established principles for nutrient profiling [DREWNOWSKI and FULGONI, 2008]: According to the relevance to dietary and health needs, it was decided to control the three disease-related, disqualifying key nutrients SFAs, sugar and sodium in an across-the-board-approach (as product categories often vary between country and culture [NIJMAN et al., 2007]). The possible devaluing of whole food categories by this approach is neglected due to the necessity of reducing the risk for chronic NCDs: The purpose and sensitivity of the HANCP tool are to detect “negative” products and dishes in order to evaluate the individual risk and reconsider their formulation (reformulation) [TETENS et al., 2007].

Daily values and benchmarks for these “index nutrients” have been set (Table 10): The so-called “Food Nutritional Objectives” or FNOs following the scientific-based dietary recommendations of WHO and EUODIET [WHO, 2003a; EUODIET, 2000] define the upper concentration level of a nutritional risk of a food at the stage of consumption. Together with the FNOs, the “Nutritional Performance Criteria” or NPCs are used to assess the nutritional risk and to establish reduction limits. At least 50% of the excess from index nutrients is aimed to be reduced while trying to get as close to the feasibility limit as possible. If the food still exceeds the FNOs, manufacturers are recommended to reduce the portion size in order to decrease the total contribution to the daily diet and consumers are asked to eat this kind of food less frequently [RMHCB, 2010a].

Moreover, it was determined to calculate the amount of nutrients on a 100g-basis in consistence with existing legislations (instead of kcal or serving) to make the concept as simple as possible and internationally comparable for the SMEs, accepting to “discriminate” unhealthier products and dishes only consumed in small amounts [TETENS et al., 2007; DREWNOWSKI and FULGONI, 2008; RMHCB, 2010a].

Table 10: Nutritional criteria of the HANCP concept [RMHCB, 2010a]

	SFAs ¹	Na ¹	Added sugar ²
<i>Food Nutritional Objectives (FNOs)</i> Benchmarks for nutrients in the food	≤ 10 [%E] [*]	≤ 500 [mg/100g food]	≤ 10 [%E]
<i>Nutritional Performance Criteria (NPCs)</i> Reduction criteria	Reduce excess by at least 50% (if necessary: adapt portion size)		
The FNOs for SFAs will vary according to the total fat content of the recipe: For a product or dish containing less than 10g fat in 100g, the FNO _{SFA} is increased to ≤15%E.			
¹ Recommendations for SFAs and Na according to EURODIET [EURODIET, 2000]			
² Recommendation for sugar according to WHO [WHO, 2003a]			

The risk for each nutrient was calculated separately. Simple and transparent algorithms for the calculations have been developed and tested during the pilots' execution in order to guarantee the effectiveness and user friendliness of the HANCP model [RMHCB, 2010a]:

$$\text{SFA } [\%E] = \sum \text{SFA}_{\text{ingredients}} [\text{g}] * 9 [\text{kcal/g}] * 100 [\%E] / E_{\text{product}} [\text{kcal}] \quad (1)$$

$$\text{NPC}_{\text{SFA}} [\%E] = \text{SFA} [\%E] - \text{FNO}_{\text{SFA}} [\%E]. \quad (2)$$

$$\text{Min. reduction objective } [\text{g}] = (\text{NPC}_{\text{SFA}} [\%E] / 2) * E_{\text{product}} / 100\text{g} [\text{kcal}] / 100[\%E] / 9 [\text{kcal/g}]. \quad (3)$$

For a better understanding, an example of an algorithm for the calculation of the NPC and the minimum reduction objective (Eq.1-3) is given: If the SFAs of a food contribute 12%E, it exceeds the FNO_{SFA} (<10%E) by 2%E. The minimum reduction should be 50% of the excess, i.e. 1%E. In this way, if 100g of food provide 500kcal, 1%E is equivalent to 5kcal or 0.56g of SFAs.

The algorithms for sugar and sodium consist of the same calculation principles as those for SFAs listed above, i.e. Eq.4-9.

$$\text{Sugar } [\%E] = \sum \text{Sugar}_{\text{ingredients}} [\text{g}] * 4 [\text{kcal/g}] * 100 [\%E] / E_{\text{product}} [\text{kcal}] \quad (4)$$

$$\text{NPC}_{\text{sugar}} [\%E] = \text{Sugar} [\%E] - \text{FNO}_{\text{sugar}} [\%E] \quad (5)$$

$$\text{Min. reduction objective } [\text{g}] = (\text{NPC}_{\text{sugar}} [\%E] / 2) * E_{\text{product}} / 100\text{g} [\text{kcal}] / 100[\%E] / 4 [\text{kcal/g}]. \quad (6)$$

$$\text{Na}_{\text{recipe}} [\text{mg}/100\text{g}] = \sum \text{Na}_{\text{ingredients}} [\text{mg}] * 100 [\text{g}] / \sum \text{Weight}_{\text{ingredients}} [\text{g}] \quad (7)$$

$$\text{NPC}_{\text{Na}} [\text{mg}/100\text{g}] = \text{Na}_{\text{recipe}} [\text{mg}/100\text{g}] - \text{FNO}_{\text{Na}} [\text{mg}/100\text{g}] \quad (8)$$

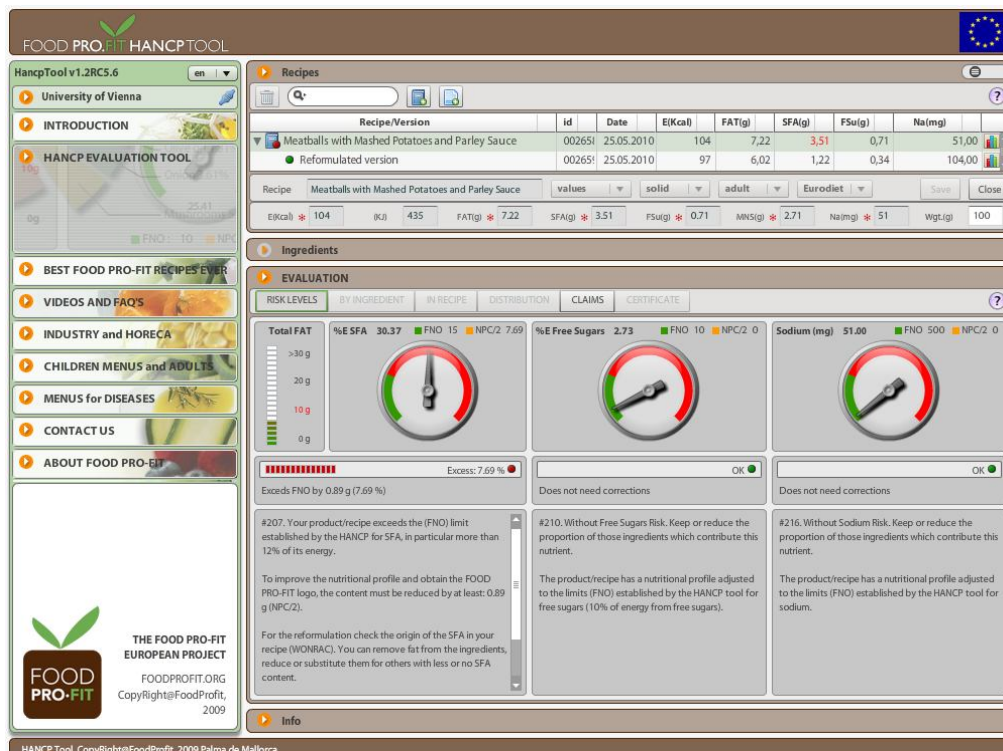
$$\text{Min. reduction objective } [\text{mg}] = (\text{NPC}_{\text{Na}} [\text{mg}] / 2) * \text{Weight}_{\text{product}} [\text{g}] / 100 [\text{g}]. \quad (9)$$

Workplace Nutritional Risk Assessment and Control (WONRAC) is aimed to ensure capturing all potential sources of the risk at the moment any of the nutrients under study are added or their concentration is altered (e.g. cooking, curing, drying etc). WONRAC is recommended for all products or dishes with >10%E from SFAs (focusing on fatty meats, creams, puff pastry and solid fats) and from added sugars (with attention on sugar, honey, syrup, fruit juices, pastries, dairy products and confectionary). Risk assessment also has to be conducted for products containing >500mg Na/100g with specific focus on products including bread, cheese, commercial sauces, smoked products, meat products and tinned vegetables [RMHCB, 2010a].

3.2.2. HANCP computer application

A computer-based HANCP application (scientific and technical development by T. Colom, M. Autonell, M. Monino) that incorporates a food composition database with energy and four key nutrients (total fat, SFAs, sugar and Na) was designed to make the implementation of the HANCP principles easier and to enable small and medium size enterprises to detect and control the amount of these substances in raw materials and ingredients during food processing and meal preparation (Fig.3) [RMHCB, 2010a].

Fig. 3: Design of the HANCP computer application web 2.0, www.hancptool.org (Screenshot)



Starting from the ingredients level, the approximation of nutrients according to the recommendations will be worked out. From the recipe included in the computer application, the amount of all nutrients at risk can be calculated and manufacturers can search for ways to improve the product or dish. In order to adapt the actual amount to the need, the composition of ingredients and recipe has to be optimized requiring mature selection of foods and production alternatives: changing the portion size or the amount of ingredients, looking for healthier options (e.g. high-qualitative oils, lean meat and milk products) or including additional ingredients with high nutritive value (e.g. vegetables, fruits).

Companies include a data sheet of each dish or product they wish to analyze that contains a complete list of ingredients and their amounts in the computer application. The necessary ingredients are to be inserted in grams of “cleaned” food after removing bones, skins etc. (net weight). In order to facilitate the data input, some coefficients for edible portions can be obtained on the online tool (e.g. tomatoes/potatoes 80-90%, plum/peach 65-75%) [RMHCB, 2010a]. Therefore, besides the most common raw materials the food composition database has to include local foods (raw/processed) typical for each region.

Several standards can be chosen for the evaluation: The standards of EFSA (SFAs and free sugars <9%E, Na <500mg) [EFSA, 2005], WHO [WHO, 2003a] or EURODIET [EURODIET, 2000] can be selected to calculate the FNOs and NPC. Moreover, in order to guarantee an accurate evaluation, the recipe can be characterized as liquid or solid, as special menus for adults or children and adjusted to water losses during cooking and processing [RMHCB, 2010a].

The real-time-evaluation of the HANCP tool allows the user to know the nutritional risk of the recipe at every stage: Due to the coloured visualization of the risk, for example in form of a tachometer or “Key Performance Indicators” that follow the traffic light system (Fig.3), the risk level of the original or with reference to the original recipe can be assessed at a glance and is easy to understand. When the sum of one of the key nutrients exceeds the food nutritional objectives (FNOs) defined by the project consortium (the tachometer is in the red area), the enterprises can look for the main sources in the database following the WONRACs, decide on potential ingredients to modify and afterwards reformulate the product or dish maintaining its characteristics: The nutritional value of the quantity of ingredients can be displayed as it is “in recipe”, “nominal” (in 100g of ingredient) or as “ratio” (in 100g of recipe) [RMHCB, 2010a].

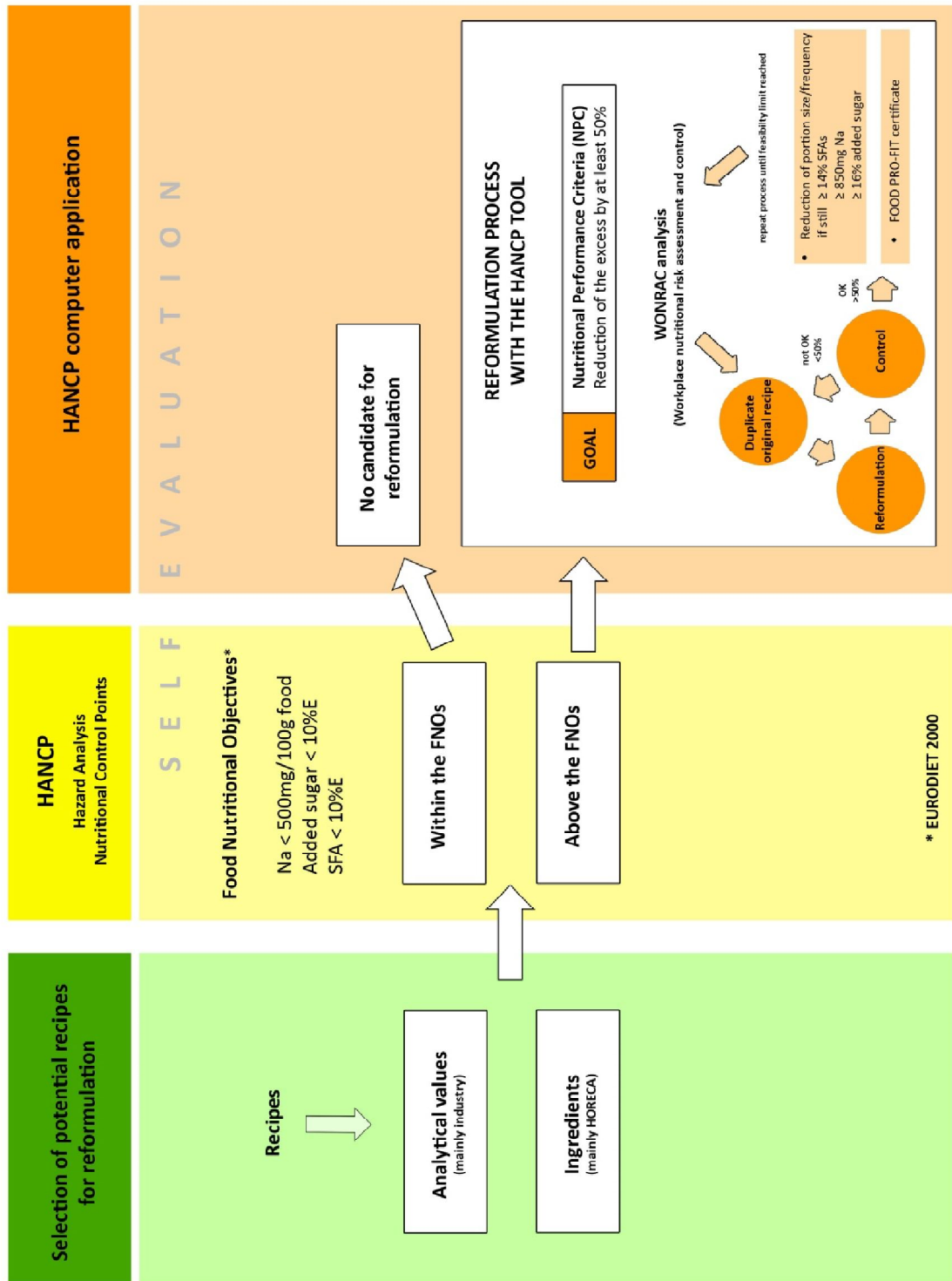
Moreover, the very innovative approach of the HANCP tool allows enterprises to check their products according to the “Regulation 1924/2006 of the European Parliament and the European Council of the 20th December 2006 related to the nutritional claims and healthy properties of foodstuffs” and get an overview of potential nutritional claims: In order to apply claims, the SMEs must strictly adhere to the European regulation. According to the regulation, nutrition or health claims shall work as incentives for food producers and providers, encourage innovation processes and lead reformulation of products and dishes in Europe towards healthier options [EC, 2006].

After a successful reformulation the SME can get a certificate with the results of the auto-evaluation that is valid for six months and is allowed to use the “FOOD PRO-FIT” label together with an informative phrase for the product or dish [RMHCB, 2010a].

Built on the concept “web 2.0”, the online, freely accessible HANCP computer tool allows direct relationship and dynamic interaction with potential users [AUTONELL et al., 2010]. This HANCP application had been tested in the two pilot countries Germany and Spain following different emphases: The Ministry of Health and Consume of the Balearic Islands worked particularly with hotels, restaurants and caterers (HORECAs) and was responsible for the development of the computer application. On the contrary, Germany represented by the European Business Centre Ltd. put the focus on collaboration with SMEs, mainly coming from the industrial sector, and working on future prospects. As the project was conceived as a pilot including research and development of the HANCP tool, errors in measurement, evaluation or recommendations could occur during the testing phase.

Before and during the frame of the pilot phase, the HANCP tool has been constantly developed, modified and improved. In the beginning, the tool worked with a simple, project specific database including about 500 ingredients, but for the improved version of the tool, it was decided to work with a EuroFIR-database that includes LanguaL codes [EUROFIR, 2011] bringing added value for the evolution of the computer application. Moreover, the plan was to develop an English application, but due to language barriers in the course of the project, the tool has been translated in the official languages of the partner countries.

Fig. 4: Simplified scheme of the HANCP self-evaluation process



3.2.3. Participating small and medium sized enterprises

Initially, it was scheduled to test the HANCP concept and the computer application in three pilot countries. The pilot phase started with the three countries Spain (Regional Ministry of Health of the Balearic Islands), Germany (European Business Centre Ltd assisted by Gercid GmbH) and Cyprus (Ministry of Health in Cyprus).

The pilots were the core of the project. In order to influence the whole food chain, every pilot partner had to recruit 8 to 15 companies from the food industry or the HORECA-sector: Whereas the Spanish pilot partner focused on the HORECA channel, the German pilot mainly comprised industrial enterprises. In October 2008, it first became obvious that Cyprus had problems in conducting its role as a pilot. Because public procurements were constantly stopping this partner from developing its role in the project, Cyprus had to quit the pilot status during the project but still remained in the team with different tasks. As there were only two pilots left for the evaluation, the informative value of the pilot phase was limited. Due to this drop out, only the results of Germany and Spain are considered in this dissertation.

SMEs in Germany and Spain willing to lower the content of the desired nutrients in their products and to improve the diet quality of their foods were recruited to test the HANCP tool and asked to sign an agreement. Constant support and cooperation with the enterprises should ensure their compliance, nevertheless because of the economic crisis and personal problems several SMEs had to quit their participation before starting or during the project phase. The following enterprises presented in table 10 accompanied the project for most of the time.

Table 11: List of SMEs participating in the project "FOOD PRO-FIT"

Spain [AUTONELL et al., 2010]	Germany [EBC.Ltd, 2010]
10 SMEs from the HORECA sector: • "Alcari Escola de Cuina", school catering • "Hotel Barceló Pueblo Park", hotel • "Escola d'Hoteleria de les Illes Balears", hotel-school • "Hospital Joan March", public health hospital • "Hotel Hipocampo", hotel • "Mas Natural", chain of restaurants • "Tiberi", catering • "USP Clínica Palmaplanas", private clinic • "Residencia UIB", University of the Balearics • "Colegio Lluís Vives", private school	5 SMEs from HORECA sector: • "Wilhelmshof", restaurant/ hotel • "Kantinen- und Konferenzservice", catering • "Bildungswerk Kreuzberg", catering • "Ribnitzer Fischhafen", restaurant • "Spreemenü", catering

7 SMEs from the food industry: • "Ca'n Balaguer", traditional "Sobrasada" (sausage) • "Gelats de Soller", ice creams and sorbets • "Mallorca BIO", vegetarian and ecological products • "Matisa", chicken hamburgers and sausages • "Piris", cheese • "Prilac", cow and goat products • "El Zagal", manufacturing "Sobrasada" (sausage)	11 SMEs from the food industry: • "Ernst & Dick", delicatessen/ fish products (fish salad) • "Lakomka Fresh Food GmbH", sweets (quark bar) • "Mecklenburgische Kartoffelveredlung Hagenow", potato products (instant potato soup) • "Greifen-Fleisch", meat products (sausages) • "Tutower Senf", delicatessen (mustard with horseradish) • "ODEGA GmbH", vegetable products (sauerkraut) • "Krügermann GmbH", vegetable products (pickles) • "Vetschauer Wurstwaren GmbH", meat products (sausages) • „Schwabenstolz", delicatessen (marinades) • "Schmidt OHG", delicatessen (meat salad with mayonnaise) • "Apolda Vereinsbrauerei", beer and soft drinks (beer-mix-drink)
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3.2.4. Quality insurance and effectiveness

Food operators and involved staff were invited to awareness-raising-courses and trained and instructed in the principles of the HANCP system and the correct use of the computer application according to their responsibilities and level of knowledge. For the successful implementation and sustainability of the HANCP project, all personnel had to be aware of their role in improving the diet quality and fully committed. Several audits should guarantee the effectiveness of the HANCP tool and the conformity of results gained by calculating with the tool's database and the prepared foods: Samples were analysed to verify the actuality of food safety, proper sensory characteristics and the realization of the necessary reductions [AUTONELL et al., 2010]. The nutritional analysis in Germany comprised the "Weillbull-Stoldt" technique to assess the total fat, gas chromatography was used for saturated fatty acids, flame photometry for sodium and HPLC, the "Luff-Schoorl" technique or enzymatic methods for quickly absorbable carbohydrates [EBC.Ltd, 2010].

In the last phase of the project, the level of acceptance within the enterprises concerning the HANCP-concept and the satisfaction of the consumers with the new products or dishes have been evaluated with questionnaires and with results gained from the online tool "Google analytics" [GOOGLE, 2011]. The HANCP instrument should increase the transparency in SMEs within all steps of the food chain from primary production via transformation up to service processes. By reformulation and

recalculation of the products and dishes and reduction of at least one of the three key nutrients, the nutritional profile of the recipes could be improved. This stimulation of food innovation and the offer of a wider choice of healthy products to citizens are expected to lead to changes in food habits [PHEA, 2007].

Evaluation indicators

The prior aim of the evaluation and validation of “FOOD PRO-FIT” was not to assess the food classification potential, but the so-called “stakeholder-related validation” including feasibility and satisfaction level [TETENS et al., 2007]. The needs assessment comprised the assessment of nutritional knowledge and awareness of SMEs, opinions on reformulation strategies and the experiences with the HANCP tool. Benefits and strengths of the HANCP concept as well as its weaknesses and limitations were collected and analysed taking into account some objective criteria and key qualities such as relevance and potential impact, simplicity for use (learnability, efficiency, memorability, satisfaction level) and sensitivity (low error rate, potential penalizations). The data were assessed with several questionnaires for the project partners, SMEs and consumers and usability tests in Germany and Spain. The evaluation indicators included the number of reformulations as well as some successful examples (including the eliminated amount of nutrients) and information on the percentage of consumers choosing “FOOD PRO-FIT” dishes and their level of satisfaction. Moreover, within the usability testing the potential, the efficacy and the fit for purpose was evaluated and ways for improvement and added user friendliness were offered.

Impact assessment

In order to evaluate the potential impact of the HANCP tool on the dietary intake, a combination of food composition data and consumption patterns had to be considered [TEMME et al., 2010].

The estimation of the actual nutrient intake (baseline) was based on food consumption data of the Austrian Nutrition Report 2008, collected in the context of a dissertation at the University of Vienna [SCHÄTZER, 2007]: The food consumption data were assessed from a representative sample of 2,480 Austrian adults in terms of sex, age (18-64), education level and region of residence. The nutritional composition of individual foods was calculated and determined by recipes using the Austrian food

composition database including the German BLS II.3.1 [HARTMANN et al., 2005]. In order to assess the daily intake per day, the individual nutrient contents from different foods were summed up. Because of missing data on sugar added to food products and dishes, the average amount of monosaccharides and sucrose was calculated in order to estimate the “added sugar” content. The actual amount of sodium in the daily diet within the Austrian Nutrition Report was probably underestimated due to the neglect of added salt at home during cooking or at the table. As the amount added from the salt cellar is rather small, this loss of accuracy is acceptable.

In order to identify the largest proportion of the variability in SFAs, sugar and sodium intake stepwise multiple regression and correlation analyses were used. All food products consumed were categorised into 22 food groups according to the BLS II.3.1 [HARTMANN et al., 2005]: Bread and rolls (B), cereal products/grains (C), cakes/pastries/biscuits (D), egg and egg products (E), fruit and fruit products including juices, jams and marmalades (F), vegetables and vegetable products (G), legumes, pulses and nuts (H), vegetarian foods (J), potatoes, starchy roots and mushrooms (K), foods for special needs/ clinical food (L), milk and milk products including cheese (M), non-alcoholic beverages and soft drinks (N), alcoholic beverages (P), oils and fats (Q), spices, seasonings (R), sweets, sugar and chocolate (S), fish and fish products (T), meat from beef, veal, pork, mutton (U), offal, venison, poultry (V), meat products and sausages (W) and composite dishes containing mainly vegetable products (X) or animal products (Y). The contribution of different food groups to total intake of the nutrient of interest was analysed in order to identify the food groups that determine the intake of SFAs, sugar or sodium: The stepwise multiple regression analysis was performed with total nutrient intake as the dependent variable and the consumption of the corresponding nutrient of all food groups as independent variables. Models were calculated that explained the biggest portion of total variation: The square of the Pearson correlation (R^2) is thereby not weakened by possible correlation with other food groups. Correlation analyses (Pearson correlation r) were a useful complement to identify those food groups that are main sources of inter-individual variability of the nutrients of interest [LECLERCQ and ARCELLA, 2001].

For the impact assessment, all foods were evaluated in relation to the compliance with the “FOOD PRO-FIT” criteria. Those beyond the benchmarks for sodium, sugar or SFAs were “reformulated” into virtual foods with nutrient contents corresponding to the FNOs (scenario 1) or NPCs (scenario 2). All nutrients that did not comply with these criteria were replaced by the adequate values in order to estimate the potential shift in

the daily intake. The quantity of all other nutrients in the original food was maintained to keep the amount of food originally consumed. The ingredients salt (e.g. added with the salt cellar) and sugar (e.g. for coffee or tea) remained unchanged. In order to favour the use of fruit and vegetables as natural sources of sugar, fresh and dried fruit as well as unprocessed vegetables and herbs were excluded from reformulation as well as nuts and honey including more than 10%E from monosaccharides and sucrose. Basic foods with more than 10%E from SFAs including eggs, nuts and seeds, vegetable oils and margarine, salmon, avocado and olives (in order to promote the positive effects of PUFAs) were not replaced for other alternatives. For scenario 1 and 2 margarine was totally or by 50% substituted for butter.

The current situation as well as the potential of reductions in sodium, sugar and SFAs on the daily intake were calculated and opposed to the nutrient intake recommendations using SPSS 17.0. The intake goals for SFAs and added sugar (<10%E) would account for 22.2g and 50g respectively in the Austrian population with an average energy intake of about 2000kcal (8.4 MJ) per day [ELMADFA et al., 2009]. Results comprise the median usual intakes of the study participants (including the 95% confidence interval for the median calculated with the bootstrapping method in the test version of SPSS 19.0) as well as comparisons of the different distribution curves.

3.3. Statistics

Due to the different ways of implementation of the HANCP concept in the two remaining pilot countries Germany and Spain, the focus on two different market segments (mainly HORECA or industry) and the use of inhomogeneous questionnaires for evaluation, the comparison between the two countries was hardly possible. The results of the pilot phase were therefore mainly presented in form of descriptive statistics.

Analyses in this dissertation comprised besides frequency distributions also t-tests, Pearson correlation and multiple regression analyses. SPSS PC 17.0 as well as Microsoft Office Excel 2007 were used for the statistical evaluation of the data. P-Values below 0.05 were discussed as significant (marked in the text and the figures as $p \leq 0.05$ *; $p \leq 0.01$ **; $p \leq 0.001$ ***).

4. RESULTS AND DISCUSSION

4.1. Attitudes of consumers and producers

The understanding of consumer behaviour and responding to their needs and expectations is one of the most important factors for food enterprises to stay competitive. The results from the questionnaire-based preliminary survey conducted on 1,410 consumers and 121 SMEs in the seven European partner countries strengthen the relevance of proposing foods with positive health benefits: Consumers, food producers and providers are increasingly aware about health issues and nutrition-related topics.

According to the interviewed consumers lifestyle choices play the most decisive role in the personal state of health. In detail, the quality of food (20%) is one of the most important determinants of health for consumers besides stress (39%) and physical activity (24%)(Fig. 5 and 6) [ASRD, 2008].

Fig. 5: Consumer questionnaire: Please rank the most important health determinants from 1 (most important) to 4 (least important), $n = 1,431$ [modified: ASRD, 2008]

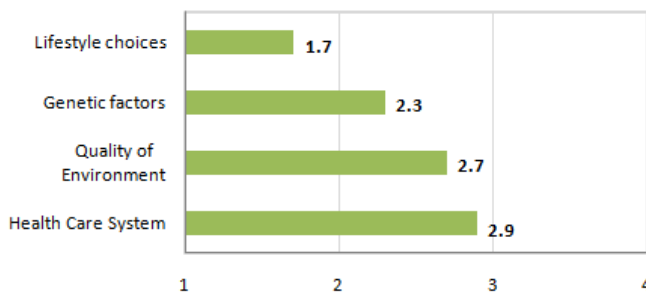
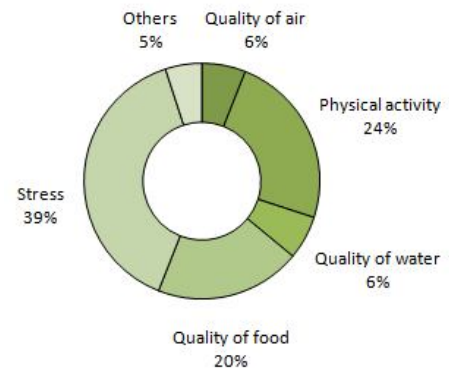


Fig. 6: Consumer questionnaire: The greatest impact on health has... (Select one answer), $n = 1,431$ [modified: ASRD, 2008]



In terms of food quality, especially food with low fat and sugar contents were considered as “healthy” and therefore these criteria also influence the food choice of consumers (Fig. 7 and 8). On the label, the respondents consequently focus on those substances trying to reduce or avoid in the diet. One of the most important aspects of a healthy diet is to eat less fatty and “fattening” foods and to cut down on salt or sugar [ASRD, 2008].

In addition to the results from the questionnaires, the consumers in the *focus groups* defined healthy food or diet as high in vitamins, dietary fibre and minerals as

well as low in additives and they stressed the importance of food quality (freshness, gentle treatment, well-balanced in nutrients, regional products) and potential to prevent diseases. Correspondingly, the determinants that influence the choice between healthy and unhealthy options of the same food (e.g. low and high fat cheese) included nutritional information and labelling (low calorie, only ...% fat, no added sugar, light), freshness and appearance of the product as well as its effect on disease prevention or the healing process. The actual weight of the respondents (obesity and standing on scales) also determined their choice. In addition, consumers in the focus groups stated that the healthiness of food does not only depend on the ingredients, but also on the ingested amount and frequency of consumption as well as individual nutritional needs.

Fig. 7: Consumer questionnaire: What is “healthy food” in your opinion? (Several choices possible), *n* = 1,431 [modified: ASRD, 2008]

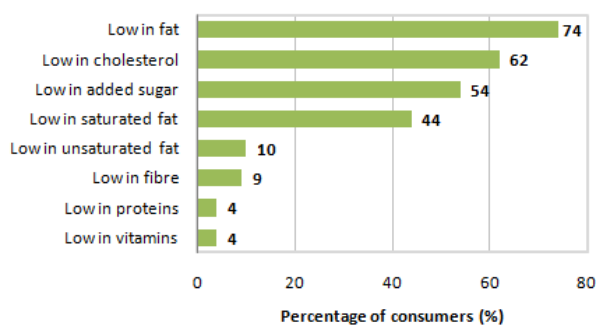
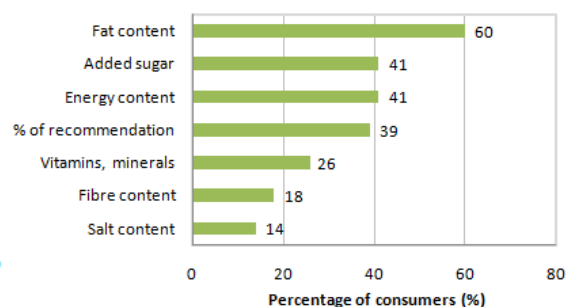


Fig. 8: Consumer questionnaire: If you choose “healthy packaged food” using the nutrition information you consider... (Several choices possible), *n* = 1,431 [modified: ASRD, 2008]



Consumers’ perceptions of “healthy and unhealthy eating” and the terminology used to classify foods obviously reflected actual dietary guidance to cut down on fat, sugar as well as salt. Literature confirms the results of the focus groups: Low or moderate intakes of “unhealthy nutrients” as well as naturalness (unprocessed foods), balance and variety of the daily diet were important characteristics of healthy eating for all consumers. Unhealthy foods generally comprised junk and processed foods, as well as sweets, sugary and salty food, whereas fruits and vegetables, fresh and organic foods as well as low fat and low calorie products were considered as healthy. The personal strategies to improve the personal diet quality included the comparison of foods and the preference of healthy over unhealthy foods, limitation of unhealthy products or simply compensating for unhealthy meals [WINTER et al., 2001; PAQUETTE, 2005]. In the primary consumer survey could be shown that due to the

increasing risk for chronic NCDs with age, the group of respondents older than 75 paid the most attention on disease-related nutrients compared with the younger generations, whereas the consumers <24 cared the least.

Although participants often try to cut down on SFAs, sugar and sodium and intentionally avoid foods with high contents of these nutrients, uncertainty persists especially when it comes to processed foods containing “invisible” amounts (e.g. bread and cereals are often high in sodium but do not taste “salty”) [WISEMAN, 1994].

In the focus groups, environmental factors – besides wrong eating behaviour and the lack of physical exercise – have been blamed likewise by consumers, HORECAs and industry as main reasons for overweight and obesity, especially focusing on the lacking availability and accessibility of healthy foods low in sugar/salt/fat as well as on too big portion sizes. SMEs and HORECAs agreed with nutritionists that effective strategies to cope with chronic NCDs therefore have to include intense cooperation of industry, scientific organisations and public authorities to provide affordable, healthier meals in adequate portions for the consumers. But some of the stakeholders raised concerns that to their mind healthier products were less tasty and more expensive than the “normal” products and dishes. With awareness-raising courses, the project “FOOD PRO-FIT” wanted to make sure that enterprises were totally aware of the adverse effects of unhealthy diets and to allay the doubts of SMEs in order to stimulate them to reformulate their products.

According to the “FOOD PRO-FIT”-survey conducted among 121 HORECAs and industrial enterprises, about 70% of the interviewed SMEs were planning to adapt their offer by proposing food products with positive health benefits. Three-quarters of these food companies thought consumers could benefit from fat reduction. Other benefits could be a better nutritive value and low contents of sugar and salt (Fig.9). Similar to the results of the consumer survey, 41% of the polled enterprises considered the nutritive value as most important determinant of “healthy food” followed by fat content (Fig.10) [ASRD, 2008].

Although some of the enterprises already try to cut down on fat, sugar and salt and focus on high quality products and gentle treatments, the focus groups revealed that besides laboratory analysis and evaluation of nutritive values, there is a need for guidance concerning reformulation strategies and a supportive tool to help during reformulation steps and the nutritional optimization of products and dishes. The designed HANCP computer application therefore was a welcomed opportunity for them to find and create healthier alternatives.

Fig. 9: What will be the main benefits (of “healthy food”) for the consumer? (Several choices possible), n = 121 [modified: ASRD, 2008]

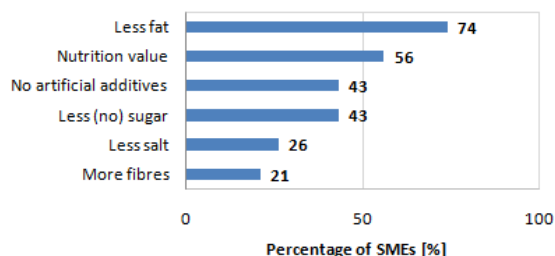
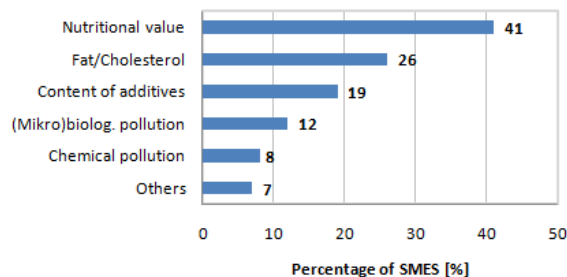


Fig. 10: What is the most important determinant of “healthy food”? (Several choices possible), n = 121 [modified: ASRD, 2008]



Generally speaking, the results from the focus groups conducted in some of the partner countries strengthened the results gained in the preliminary study. There was a trend towards rising awareness among consumers and SMEs concerning diet-related diseases and the importance of improving food nutritional characteristics and food habits. Concerns have been raised regarding the feasibility of reformulations, legislative limitations or the price and taste of the “healthier products”. Therefore, an important aim of the pilot phase was to find out about the potential, the strengths and limitations of the HANCP concept.

4.2. Potential impact factor

In order to estimate the potential impact of the reformulation techniques on the diet quality and public health taking into account the actual eating behaviour and staying as close to reality as possible, shifts in nutrient intakes were assessed by statistical modelling of Austrian food consumption and composition data collected for a dissertation at the University of Vienna [SCHÄTZER, 2007]: The average intake of all nutrients under study is well above the recommendations fixed by WHO or EURODIET [WHO, 2003a; EURODIET, 2000]. About 19%E of the average Austrian diet consist of SFAs (36g/d). Monosaccharides and sucrose contribute around 18%E to the total energy intake (73g/d), whereas sucrose itself accounts for 9%E or 35g. All mono- and disaccharides in the Austrian diet account for 20%E (80g). The average intake of sodium is 3g/d.

The main food groups that determine the daily SFA, sugar and sodium intake are listed in the tables 12 to 14: Composite meals were always to find within the TOP5 food groups that explain the most of the observed variability – in the case of sodium

and saturated fat, processed meals were responsible for more than 60% of the inter-individual variability in daily intakes. Meat and meat products as well as milk and milk products also contributed quite a lot to total Na and SFA intake. Although they do not taste themselves salty, cakes, pastries and biscuits are also found among the top 6 food groups explaining the sodium intake.

The variability in sugar intake can mainly be explained with the intake from the food groups including fruit juices and jams, sweets and non-alcoholic drinks, especially soft drinks.

Table 12: Identification of the main food groups that determine the daily total SFA intake in the Austrian population through stepwise multiple regression (R^2) and correlation analysis, $n=2,480$ – based on Austrian raw data by Schätzer [SCHÄTZER, 2007]

Food groups	R^2 Explained variability	Correlation with total SFA intake	Average contribution to total SFA intake (mean)	
			[g]	[%]
<i>X – Composite dishes (vegetable prod.)</i>	0.42 ***	0.65 ***	16.9	43
<i>Y – Composite dishes (meat prod.)</i>	0.61 ^a ***	0.44 ***	7.2	19
<i>M – Milk products including cheese</i>	0.73 ^b ***	0.29 ***	4.7	12
<i>W – Meat products and sausages</i>	0.81 ^c ***	0.22 ***	2.9	8
<i>Q – Oils and fats</i>	0.87 ^d ***	0.35 ***	3.4	9
<i>S – Sweets, sugar and chocolate</i>	0.92 ^e ***	0.28 ***	1.3	3
*** $p \leq 0.001$; ^a regression model including X+Y; ^b regression model including X+Y+M; ^c regression model including X+Y+M+W; ^d regression model including X+Y+M+W+Q; ^e regression model including X+Y+M+W+Q+S				

Table 13: Identification of the main food groups that determine the daily total sugar intake (monosaccharides and sucrose) in the Austrian population through stepwise multiple regression (R^2) and correlation analysis, $n=2,480$ – based on Austrian raw data by Schätzer [SCHÄTZER, 2007]

Food groups	R^2 Explained variability	Correlation with total sugar ¹ intake	Average contribution to total sugar ¹ intake (mean)	
			[g]	[%]
<i>F – Fruits and fruit prod. (juice, jam)</i>	0.59 ***	0.59 ***	32.7	38
<i>S – Sweets, sugar and chocolate</i>	0.76 ^a ***	0.49 ***	14.3	17
<i>N – Non-alcoholic beverages</i>	0.84 ^b ***	0.33 ***	7.5	9
<i>X – Composite dishes (veg. prod.)</i>	0.89 ^c ***	0.39 ***	15.9	19
<i>Y – Composite dishes (meat prod.)</i>	0.90 ^d ***	0.17 ***	3.2	4
<i>D – Cakes/pastries/biscuits</i>	0.91 ^e ***	0.10 ***	1.7	2
*** $p \leq 0.001$; ¹ monosaccharides + sucrose; ^a regression model including F+S; ^b regression model including F+S+N; ^c regression model including F+S+N+X; ^d regression model including F+S+N+X+Y; ^e regression model including F+S+N+X+Y+D				

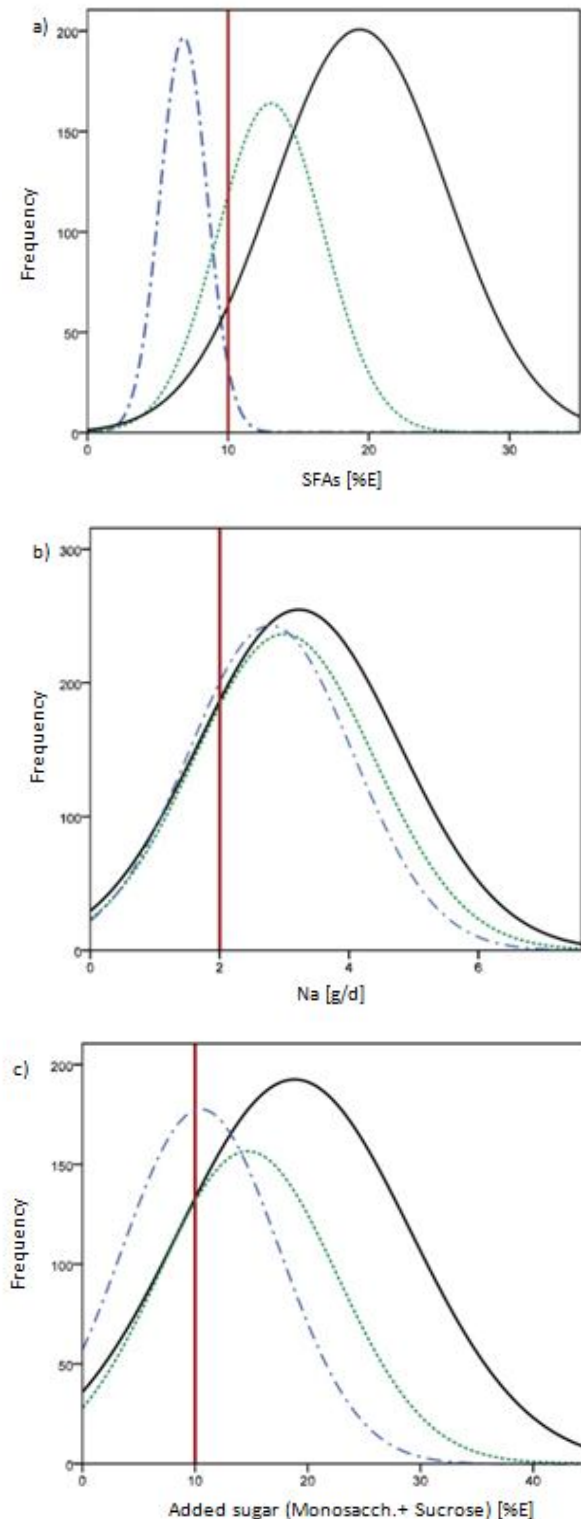
Table 14: Identification of the main food groups that determine the daily total sodium intake in the Austrian population through stepwise multiple regression (R^2) and correlation analysis, $n=2,480$ – based on Austrian raw data by Schätzer [SCHÄTZER, 2007]

Food groups	R^2 Explained variability	Correlation with total Na intake	Average contribution to total Na intake (mean)	
			[g]	[%]
<i>X – Composite dishes (vegetable prod.)</i>	0.45 ***	0.67 ***	1.46	45
<i>Y – Composite dishes (meat prod.)</i>	0.79 ^a ***	0.38 ***	0.54	17
<i>W – Meat and meat products</i>	0.91 ^b ***	0.35 ***	0.30	9
<i>B – Bread and rolls</i>	0.95 ^c ***	0.38 ***	0.47	15
<i>M – Milk and milk prod. Including cheese</i>	0.97 ^d ***	0.21 ***	0.22	7
<i>D – Cakes/pastries/biscuits</i>	0.98 ^e ***	0.15 ***	0.04	1
*** $p \leq 0.001$ ^a regression model including X+Y; ^b regression model including X+Y+W; ^c regression model including X+Y+W+B ^d regression model including X+Y+W+B+M; ^e regression model including X+Y+W+B+M+D				

Would all foods not complying with the HANCP criteria be improved corresponding to the nutritional performance criteria (NPC, reducing 50% of the excess), 11.5g of SFAs (32% reduction, Fig.11a) and 16.2g of monosaccharides and sucrose (referred to as “added sugar”) per day (22%, Fig. 11c) could theoretically be removed from the average Austrian diet. The sodium intake could be reduced by 160mg/d or 6% (0.4g NaCl, Fig.11b). In the most optimal replacement scenario, where all foods consumed would be within the food nutritional objectives (FNOs) fixed by the “FOOD PRO-FIT”-consortium, the decrease would amount to 65% of SFAs, 47% of sugar and 12% of sodium (Table 15).

Major compositional shifts to reduce the amount of SFAs comprised milk products including cheese (26%), meat products and dishes (21%), as well as sauces/dressings/spreads (16%). Sweets, cakes and chocolate would account for 11% of SFA sources. The main sources of the disease-related nutrient sodium were meat products and dishes (37%), cheese (22%) and sauces/dressings/spreads (13%). 11% of the compositional shifts included bread and cereal products and 9% vegetable products and dishes. Salt as single ingredient would only account for 4% of sources of sodium and was not changed in order to focus on processed foods.

Fig. 11 (a-c): Distribution of nutrient intakes “as measured” (—; baseline situation) as well as of the two replacement scenarios “NPC” (····; 50% reduction of the excess) and “FNO” (— · —; food within food nutritional objectives) compared to the intake recommendation by WHO (—) [WHO, 2003].



The reduction of the amount of sugar used in canned fruits with syrup, processed vegetables, soft drinks (31%, including fruit juice, lemonades and syrups), sweets/cakes/chocolate (24%), processed vegetables (13%) dairy products would comprise the major sources of added sugar. Jam and canned fruits (with syrups) as well as milk products account for another 9% (respectively) of all sources contributing to the excess in added sugar.

Results from a Dutch study showed similar trends while additionally taking into account the actual market share: Substituting non-complying foods by available foods in accordance with the “Choices” health logo criteria would lead to a significant decrease in SFAs, sodium and sugar. When taking into account only those foods for which “health logo foods” were available in 2007, the reduction potential was about 2.5% for SFAs and 1% for added sugar, sodium remaining unchanged. In the most optimal replacement scenario seen in Table 15 based on 100% market shares and substitution of all non-complying foods up to 40% of SFAs, around 20% of sodium and 36% of sugar could be removed from the Dutch diet [TEMME et al., 2010].

Table 15: Nutrient intakes “as measured” (Baseline) and estimated from various replacement scenarios including the reduction potential in Austria and the Netherlands

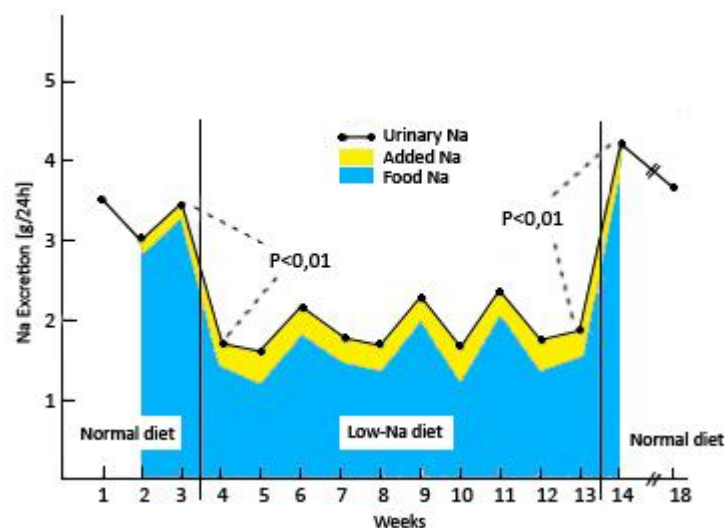
	AUSTRIA		NETHERLANDS [TEMME et al., 2010]	
	Scenario ¹	Median [g/d] (95%CI)	Scenario ²	Median [g/d] (95%CI)
SFAs	As measured	36.2 (35.3; 37.0)	As measured	31.9 (31.0; 32.9)
	NPC	24.7 (24.0; 25.2) REDUCTION: 32%	All foods consumed according to “Choices” criteria, 100% market share	19.0 (18.6;19.6) REDUCTION: 40%
	FNOs	12.8 (12.4; 13.1) REDUCTION: 65%		
Na	As measured	2.99 (2.93; 3.07)	As measured	2.86 (2.78; 2.94)
	NPC	2.83 (2.76; 2.89) REDUCTION: 6%	All foods consumed according to “Choices” criteria, 100% market share	2,21 (2.16; 2.29) REDUCTION: 23%
	FNOs	2.63 (2.58; 2.69) REDUCTION: 12%		
Sugars	As measured ³	73.4 (70.4; 76.0)	As measured ⁴	138.6 (134.3; 142.3)
	NPC ³	57.2 (55.6; 59.7) REDUCTION: 22%	All foods consumed according to “Choices” criteria, 100% market share ⁴	88.5 (85.8; 91.6) REDUCTION: 36%
	FNOs ³	39.1 (37.6; 40.4) REDUCTION: 47%		
¹ “As measured“ includes the results of the baseline; “NPC” = reducing 50% of the excess; “FNOs” = all foods consumed according to the nutritional objectives (max. 10%E from SFAs/added sugars and 500mg Na/100g) ² “Choices” generic criteria: SFAs/added sugars <13%E, Na <1.3mg/kcal (specific criteria per food group) [CHOICES,2010] ³ Total amount of monosaccharides + sucrose; ⁴ Total amount of mono- and disaccharides				

All nutrient intakes could be improved when exploiting the potential from the HANCP tool: These scenarios display only optimal situations implying that manufacturers, retailers and caterers offer healthier options as well as consumers change their nutritional behaviour and choose these alternatives [ROODENBURG et al., 2009]. The actual numbers are only estimates resulting from the replacement of unhealthy foods with fictive foods corresponding to the HANCP criteria. Moreover, the self-reported consumption data might not fully reflect the actual intake as snacking, drinks or added salt is often underreported. Possible consumption of bigger portions of the reformulated food due to energy adaption (esp. with SFAs and added sugar) was not taken into account. In the Dutch study energy intakes decreased around 15% when choosing the “Choices foods”. Although smaller, the reduction potential for all three

nutrients under study remained apparent after correcting for energy [ROODENBURG et al., 2009].

The scope of possible reduction levels with the HANCP tool is promising and although the final decision on the individual diet quality lies upon the consumers, the food sector could help customers to make the healthier choice the easiest. Nevertheless the risk remains that consumers reject the reformulated products due to unfamiliar sensory properties and look for other alternatives or – in the case of sodium – reach for the salt cellar to spice up the food. In the case of the latter, Beauchamp et al. could demonstrate that the compensation is rather small (Fig.12): The test persons with average daily intakes of sodium around 3.1g (7.8g salt) were offered a Na-reduced diet containing only half the amount of salt they were used to (1.6g Na or 4g NaCl) for 10 weeks. The subjects compensated for the loss in palatability with increased use of added salt, but this made up for only 20% of the reduction (about 0.7g NaCl) [BEAUCHAMP et al., 1987].

Fig. 12: Mean 24h-urinary-sodium-excretion [g/24h] of subjects consuming their normal diet (3.1g Na) or modified low-sodium diets (1.6g Na) with free use of the salt cellar during 18 weeks of study (n =11) [modified BEAUCHAMP et al., 1987]



Even with people being allowed to use the salt cellar ad libitum, significant decreases in sodium intakes are likely to be expected from reformulated products and dishes [BEAUCHAMP et al., 1987]. The reduction of 50% of salt contributed by

processed food would theoretically bring the intake in line with actual recommendations and the FNO for sodium (Table 16).

Table 16: Required salt reduction to bring ingested salt in line with actual intake goals

Average salt intake (IN EUROPE)	Target	Required reduction
Average intake¹ 8.0g	5.0g³	
Table/cooking (15%) ² 1.2g	1.2g	No reduction
Natural (10%) ² 0.8g	0.8g	No reduction
Food industry + HORECA (75%) ² 6.0g	3.0g	50% reduction
¹ ELMADFA et al., 2004 ² EFSA, 2005 ³ EURODIET, 2000		

Without additional public health measurements including to take the unhealthy options off the market, or to make the healthier products the cheaper ones (or at least not more expensive) with the help of pricing policies, subventions or taxes, consumers will probably not directly change their dietary behaviour and fully replace the original option by reformulated, healthier products and dishes [VAN RAAIJ et al., 2008]. As it can be seen from the rise of the subjects' sodium excretion diet when returning to the normal diet (Fig.12), there is little chance that changes in taste and food preferences will occur unless people are required to change their dietary behaviour [BEAUCHAMP et al., 1987]. Therefore, the effective potential impact of the HANCP tool on diet quality and health in Europe will probably only not become apparent until environments are changing.

4.3. Reformulations

The reformulations were targeted on improving the nutritional quality of existing foods not to create new ones and mainly comprised foods within the priority categories set by the "FOOD PRO-FIT" consortium. The potential food contained food groups that accounted the most for the intake of the disease-related nutrients including bread, meat and meat products and cheese (Sodium and/or SFAs), solid fats, dairy products, pastries (SFAs and/or sugar) as well as drinks and sweets (sugar) [AUTONELL et al., 2010]. The aim of the project "FOOD PRO-FIT" was not to develop new technological strategies but to test the feasibility of simple, existing strategies to reduce the amount of the nutrients under study together with the SMEs building on

experiences and successful reductions. “FOOD PRO-FIT” encouraged the participating companies to work towards the reduction targets and to share any concerns and examples of best practice with the pilot partner or also with other companies.

The reformulations with the HANCP-tool of more than 200 dishes and products, conducted in the pilot countries Spain and Germany in collaboration with 14 HORECAs and 16 SMEs from the industry, were quite successful in reducing the content of sodium, sugar and saturated fatty acids while maintaining the taste and characteristics expected by the consumers (Table 17).

Table 17: Number of dishes/products and “target nutrients” reformulated with the HANCP tool in Spain [RMHCB, 2010b]

HORECA Recipe Group	Totals	Pre- selection	SFAs	Sugar	Na	SFA+Na	SFA+Sugar	Reformulated
<i>Vegetables, soups</i>	237	65	21				2	23
<i>Dressings, sauces</i>	57	24	5					5
<i>Rice, pasta, bread</i>	192	89	21		15	1		37
<i>Meat, eggs</i>	247	100	30			3		33
<i>Fish</i>	123	35	11			1		12
<i>Desserts</i>	137	104	8	15			11	34
SUM	993	417	93	18	15	5	13	144 all available
INDUSTRY Product Group			SFAs	Sugar	Na	SFA+Na	SFA+Sugar	Reformulated
<i>Ice cream</i>				4				4
<i>Yogurts</i>				3				3
<i>Cheese</i>			1		2	1		4
<i>Burger</i>					3			3
<i>Sausages</i>					5			5
SUM			1	7	10	1		19 not all available

As can be seen in table 17, Spain focused on reformulations in the HORECA sector, allowing them to improve a lot of dishes: From 993 available and reviewed recipes, 417 were preselected and identified as potential candidates for risk assessment and reformulation. In the end, the nutritional quality of the checked recipes could be successfully improved in 15% of the cases. The principal target in the HORECA channel was the reduction of saturated fatty acids (77% of all changes). The reformulation processes in the industry sector turned out to be more challenging and time-

consuming – the reason why only 19 products have been reformulated and to the end of the project, not all of them were available on the market [AUTONELL et al., 2010].

The pilot in Germany focused on the industry sector and had to cope with various difficulties like legislative, technological and safety aspects as well as feasibility limits. Whereas in the 5 participating SMEs from the HORECA sector, at least once a week a “FOOD PRO-FIT”-dish could be served, the 9 companies from industry had to struggle to successfully reformulate the products. In both sectors, the focus was put on the reduction of SFAs and sodium, as can be seen by a selection of 30 reformulated products and dishes (Table 18) [EBC.Ltd, 2010].

Table 18: Distribution of “target nutrients” in 30 selected, reformulated products and dishes in Germany (Results from hancptool.org) [EBC.Ltd, 2010]

Recipe group (products and dishes)	SFAs	Sugar	Na	SFA+Na	SFA+Sugar	Reformulated
<i>Meat products and dishes</i>	4		9	4		17
<i>Sweets and desserts</i>	2	1			1	4
<i>Vegetable products</i>			2			2
<i>Mixed dishes</i>	5					5
<i>Mustard</i>			1			1
<i>Fish</i>			1			1
SUM	11	1	12	4	1	30 not all available

All changes in the food production concepts during the pilot phase of the project “FOOD PRO-FIT” covered at least one of the following points for the three nutrients at risk: sodium, SFAs and sugar.

4.3.1. SODIUM

Reductions of sodium as sodium chloride (goal: <500mg Na/100g food) could be achieved by the simple reduction of added salt and by the (partly) substitution with herbs and spices or salt surrogates (e.g. potassium or magnesium salts). The overall aim of the sodium reduction was to test the feasibility levels of these strategies and to keep the added salt as low as possible while maintaining the taste and help consumers to gradually accept less salt in everyday food.

The perception of “saltiness” mainly depends on the viscosity of a food and the temperature due to the relation between diffusion rate and the reaction on taste (higher viscosity levels and temperature demand higher concentrations of salt) [PAULUS and BRAUN, 1986]. Evidence suggests that about 80% of the ingested salt are not detected by taste receptors, but methods aiming to improve the solubility of sodium in order to reduce the necessary amount are still in the initial stage [FND, 2010].

With the selection of “low-salt” ingredients and products with <0.1g sodium/100g (e.g. cereals with no added salt, breads containing less than 0.4g sodium per 100g) the total amount of sodium in “FOOD PRO-FIT” dishes could be easily reduced [GILBERT and HEISER, 2005].

Another strategy is the reformulation of the brine and desalting or shorter salting periods which lead to significant reductions in sodium levels. Sodium contents can also be lowered by avoiding to add salt to the cooking water (e.g. in the case of pasta).

An example for a successful reformulation during the project was the development of “La salchicha de siempre” in Mallorca, Spain. With the method of desalting of the gut, the sodium content could be reduced from 1,860mg to 1,116 mg/100g. Although further reductions were limited due to the wrinkling of the gut and even though the product still contained a very high amount of sodium, the measure pointed into the right direction and resulted in a “healthier” version [RMHCB, 2010b].

Mixtures from onion, garlic, mustard, thyme, celery seeds and lovage are also often used to replace salt and might simulate a “salty taste” – especially nutmeg and pepper can compensate for sodium chloride to some extent according to literature [FND, 2010]. Alternative flavours including vinegar or lemon could spice up a food, whereas soy sauce and ketchup should be avoided [GILBERT and HEISER, 2005]. Flavouring mashed potatoes with garlic lowered the threshold for salt to 0.36% and using the hotter spice pepper reduced the threshold even further to 0.31%. The more flavours and spices a dish contains, the easier is the reduction in sodium [MITCHELL et al., 2009]. The substitution with herbs and spices becomes even more important for health as, in addition to the role of reducing sodium intakes, they are regarded as natural sources of antioxidants [TAPSELL et al., 2006].

In foods with no extra flavours added to the basis, the reduction of salt was challenging as it represented the main element for the flavour experience and

consumer satisfaction [WILLIAMS et al., 2003]. Good results concerning the salt reduction and still retaining a salty taste could be obtained by the use of salt surrogates. The most prominent potassium and magnesium salts allowed in the European Union include the following salts [EC, 2006]: Potassium chloride is the most frequently used mineral salt in the food industry besides NaCl due to medical and economic aspects, but has a considerable bitter taste and high hygroscopic potential (necessitates water-impermeable packaging) [PAULUS and BRAUN, 1986]. The mineral potassium is prevalent in the human body (intake recommendation 1,000mg/d). Except for kidney patients, no adverse affects are to be expected by a substitution of NaCl by KCl, on the opposite potassium could improve public health offering additional antihypertensive effects due to its role in the regulation of blood pressure. Due to the bitterness, the common feasibility limit is a blend of 50:50 NaCl/KCl. The use of the amino acid L-lysine or high levels of herbs and spices could help to mask or even neutralize the bitter taste and help to reduce sodium even further [MITCHELL et al., 2009; FND, 2010].

Other common salt substitutes include potassium sulphate (K_2SO_4 , E515: present in mineral waters), -citrate, -bicarbonate and -phosphate as well as magnesium sulphate ($MgSO_3$, E518: firming agent in vegetable products) or ammonium chloride (NH_4Cl , E510: acidity regulator) and calcium carbonate ($CaCO_3$, E170). Flavour enhancers based on amino acids and nucleotides such as glutamates (MSG E621), guanylic acid (E623) or inosinic acid (E630) intensify the salty taste and odour of a food. Natural flavour enhancers like “yeast extracts” tasting bouillon-like (in low concentrations of 0.25-2% reduction potential about 40-50%) and “hydrolyzed vegetable protein products” with their meaty aftertaste are also applied to reduce the amount of NaCl in foods [MITCHELL et al., 2009; FND, 2010]. In general, salt could be substituted by the different aromatic substances up to 50% without significant change of taste due to literature [PAULUS and BRAUN, 1986].

In terms of the “network of efficiency”, the pilot country Germany was working together with the company Dr. Paul Lohmann GmbH KG that produces a salt surrogate reduced in sodium (Na-reduction from 50 to 100%) with mixtures of different minerals [LOHMANN, 2010]. In collaboration with this company the content of sodium could be significantly reduced in some of the German products and dishes. In a stepwise reduction process the sodium content in salted herring could be successfully decreased by 44% (Fig. 13) [EBC.Ltd, 2010].

Fig. 13: Stepwise reduction of “salted herring” with LOMA-salt [EBC.Ltd, 2010]



The use of salt surrogates was especially sufficient in meat products, but the high costs were among the main constraints for SMEs to resort to them more often. Moreover, the use of substitutes would not be optimal to achieve consumer acceptance as costumers ask for “natural” foods with as little additives as possible. Many companies are inclined to relinquish surrogates identified by “E-numbers” on their products because of the tattered reputation in the public. Potassium chloride for instance sounds not familiar and more chemical for consumers than “salt” [FND, 2010].

To conclude, food manufacturers can adopt various reformulation strategies when it comes to salt reduction, but all have several weaknesses. Salt surrogates might be the most effective but often lead to taste anomalies and together with flavour enhancers, they suffer from compromised reputation and acceptance by consumers. Physical stimulation of taste receptors including multisensory approaches with shorter but more intense salt pulses (alternating amounts of salt instead of uniform distribution) could have great potential in future but at the moment these alternatives are more costly and therefore not appreciated by SMEs. The simple, gradual reduction of salt as ingredient and the selection of low-salt ingredients may be the most time consuming option but was the cheapest and easiest strategy for SMEs participating in the project “FOOD PRO-FIT” [FND, 2010].

4.3.2. SFAs

The reduction of SFAs (goal: <10 %E) was accomplished by simply reducing the amount of ingredients that are the main sources for SFAs (including spreads, fillings and toppings), by changing the type of fat (e.g. new frying oil) or using reduced-fat versions (e.g. skimmed milk). Butchery and trimming methods including the removal of subcutaneous or visible fat or purchase of low-fat fractions of meat (e.g. breast meat) could also contribute to improved nutritive quality. With the right choice of ingredients the content of SFAs could be altered quite easily, due to the different content of SFAs in foods (Table 19 to 21).

Table 19 and 20: Examples for SFA sources per 100g of food [HARTMANN et al., 2005]

	kcal	Fat [g]	SFAs [g]		kcal	Fat [g]	SFAs [g]
<i>Rape seed oil</i>	875	99.0	7.7	<i>Milk, skimmed</i>	36	0.1	0.1
<i>Sunflower oil</i>	882	99.8	11.6	<i>Milk, semi-skimmed</i>	48	1.6	1.0
<i>Olive oil</i>	881	99.6	14.7	<i>Milk, whole</i>	64	3.5	2.1
<i>Margarine</i>	709	80.0	20.3	<i>Cream, 30% fat</i>	288	30.0	18.2
<i>Butter</i>	741	83.2	50.5	<i>Cream, 40% fat</i>	358	38.1	23.1

Existing strategies to replace fat, especially SFAs, aim at prohibiting excessive energy intakes, increasing the intake of complex carbohydrates and promoting a healthy diet. Ingredients as substitutes for fat are manifold with different physical and chemical characteristics and functions including carbohydrates, mixtures of proteins, emulsifiers or non-absorbable lipids. Gelatine, cellulose derivatives or modified glucose polymers are carbohydrate- and protein-based ingredients that can promote fat-like textures especially in foods with high water contents that are not treated with high temperature. Polyglycerol esters, lecithin or milk proteins can also help to remove fat from a food. The use of poorly or non-absorbable lipids is no preferred option of reformulation due to the reduced absorption of the fat-soluble vitamins A and E (D/K only conditionally required) and laxative properties with high intakes, although functional and sensory properties would be similar to fats. Although fat replacers generally do not seem to lead to nutrient deficiencies (a supplementation with fat-soluble vitamins could nevertheless be reasonable to compensate for potential losses), these options are rather expensive compared with the simple reduction strategies adopted within the project “FOOD PRO-FIT” [MELA, 1996]. Moreover, it is easier to

change the quality of fat (MUFAs and PUFAs instead of SFAs) than to reduce or replace it.

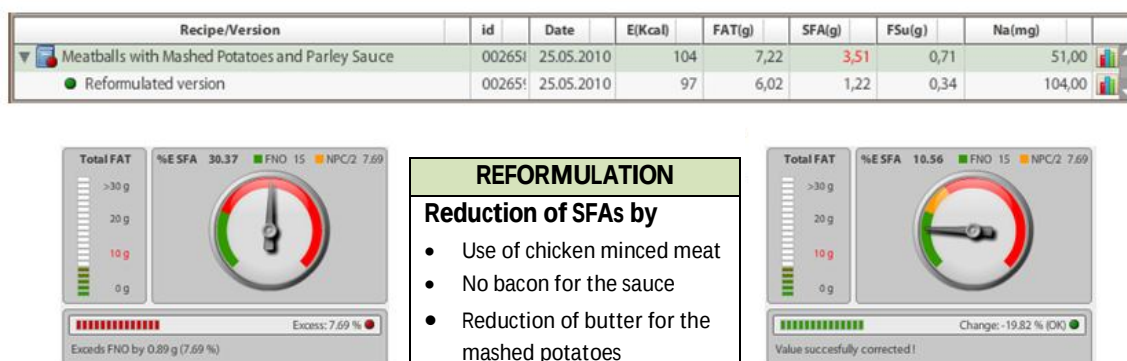
Table 21: Examples for successful reductions of SFAs in various products and dishes [RMHCB, 2010b]

RECIPE	ORIGINAL		REFORMULATED		METHOD
	kcal/100g	SFAs /100g	kcal/100g	SFAs /100g	
<i>Pasta carbonara</i>	263	9.8g (34%E)	187	4.3g (21%E)	Half of the cream was replaced by semi-skimmed milk and the percentage of olive oil was increased. Bacon was replaced by chicken without skin.
<i>Cappelletti</i>	278	4.2g (14%E)	274	3.5g (11%E)	Cured cheese reduction. Cream replaced by whole milk. Added salt reduction.
<i>Rice pudding</i>	127	1.7g (12%E)	105	0.8g (7%E)	Whole milk replaced by semi-skimmed milk.

Most of the products and dishes in the HANCP-testing phase have been reduced in SFAs. One very successful example from the German pilot partner EBC Ltd for the reduction of SFAs is presented in Fig.14. The content of SFAs has been significantly reduced from originally 30%E to only 10%E by simple measures. This is a reduction of the excess by 100%.

Fig. 14: Example for the successful reformulation of a German dish [EBC.Ltd, 2010]

Meatballs with mashed potatoes and parley sauce



4.3.3. SUGAR

A decreased amount of added sugars (goal: <10%E) could be achieved by the simple reduction of added sugar as seen in table 22, as well as using natural sweeteners (enhanced use of fruits and milk products as ingredients) or a mix of polydextrose, fructo-oligosaccharides and sweeteners.

Table 22: Example for a successful sugar reduction [RMHCB, 2010b]

Recipe	Original		Reformulation		Method
	kcal/100g	sugar /100g	kcal /100g	sugar /100g	
Chocolate sponge	421	32g (30%E)	425	20g (19%E)	Added sugar reduction

Sugar is the most controversially discussed nutrient among the nutrients of risk. Sugar is important for sweetness, colour, eating quality and structure of the final product, but with regard to the current burden of obesity these “empty calories” should be reduced [LÜFTENEGGER and ELMADFA, 2009]. Nevertheless, during the testing phase the least products have been reduced in added sugar.

4.4. Limitations, challenges and solution strategies

Although there is a demand in consumers for healthy and nutritious food products and reformulation of commonly eaten foods is regarded as one of the key strategies towards nutrient intakes adjusted to the recommendations [VAN RAAIJ et al., 2008], the “FOOD PRO-FIT” reformulation concepts sometimes failed already in the beginning or the reformulated products lacked desired sensorial properties and extended shelf-life. In some special cases limits for the reformulation could be shown during the pilot phase of the project.

4.4.1. Legislative limitations

Some dishes and products could not be reformulated due to legislative limitations as there are regulations for the composition of foods (e.g. the regulation in Codex Alimentarius for some sausages or cheese). Every country has to check its existing legislation, which limits the amount of reformulation: e.g. Codex Alimentarius

Austriacus (Austria), Codex Alimentarius Europaeus (EU), Deutsches Lebensmittelbuch (Germany). But as the following two examples from published data show, there is often still some reduction potential within the legislative range: In the UK for example cheddar cheese is subject to legislative aspects with a minimum fat content of 29.3%. However, most available cheddar cheeses contain about 34% total fat. A total fat reduction in the range of cheddar of up to 13% would be legally possible [FSA, 2007]. The second example was done by the research institute Agroscope Liebefeld Posieux who tested the salt reduction potential in cheeses. According to them it is possible to substitute NaCl by max. 30% KCl in the cheese “Raclette Suisse”. Due to legislation and recommended salt contents, they also showed that there is still reduction potential in NaCl [JAKOB, 2008; LÜFTENEGGER and ELMADFA, 2009].

4.4.2. Technological challenges

With some products and dishes the pilot countries were challenged by **technological borders**, like a bad consistence of sauerkraut with low levels of sodium due to the microbial growth (salt inhibits the growth of undesired bacteria in the fermentation process [FND, 2010]) or the wrinkling of sausages with excessive salt reduction [EBC.Ltd, 2010; AUTONELL et al., 2010]. Moreover, certain amounts of sugar were necessary in ice creams due to anti-freezing properties and sponge cakes for the right texture [RMHCB, 2010b].

With the widespread demand for low-calorie and healthy foods, the food sector is challenged to find ways to produce healthier foods that maintains the same appearance, texture, stability and flavour as the “unhealthy” analogue. SFAs, sugar and sodium possess typical technological properties that determine the quality of the dish and product, therefore certain amounts of these nutrients cannot be removed until technological innovations undertake this task [VAN RAAIJ et al., 2008]. The fine line between technological feasibility and necessary reduction often demanded several product reformulations. Many examples and case studies of food reformulation successes in Europe and within the scope of the project “FOOD PRO-FIT” show that a reduction of sugar, SFAs and Na is often technically challenging but possible. There are still huge variations in the content of those nutrients in similar products (e.g. cereal and cereal products 0-2,335mg Na/100g; meat and meat products 0-3,300mg/100g [WEBSTER et al., 2009] and it would be necessary to continue the reformulation efforts until the feasibility limits are reached.

Nevertheless, sometimes there was an irreconcilable gap between **consumer demands** and the recommended reduction goals (happening in Germany for example in the case of a fat-reduced version of “Tiramisu”). It is a challenge for the enterprises to combine consumer acceptance (convenient to use, nutritious and tasty), technological aspects and nutritional composition: Indulgence of food cannot by implication be subordinated to healthiness.

The SMEs were conscious concerning the problem of “flavourless healthy foods” and looked for strategies to maintain full taste and palatability in the healthier options. Under these circumstances, several product options to suit different tastes (like one with low and one with originally high fat content) – as choice increases acceptance – and stepwise changes in the formulation were recommended in order to maintain consumer acceptability [SFDF, 2010]. Evidence suggests for instance that the preferred salt concentration in foods depends amongst other things (like viscosity or temperature of the product) on the actual salt concentration in the daily diet and personal preferences. It could be shown that the preference can be altered to reasonably low-salt products using step-wise reformulation [PAULUS and BRAUN, 1986; LÜFTENEGGER and ELMADFA, 2009]. Small reductions of salt of 10-20% cannot be detected by taste receptors and do not result in technological or microbiological problems [HE et al., 2008]. Slow but steady reductions could therefore allow customers to get used to the nutritionally improved product or dish and to decrease their preference for salted, sugared and high fat foods.

In general, the acceptability of a complex food is easier to maintain, especially if only one nutrient is changed, because the impact on the overall perception is rather small [MITCHELL et al., 2009]: A “FOOD PRO-FIT” consumer analysis in Germany revealed that the acceptance or even the preference of reformulated options rises with increased similarity to the original food [MENZE, 2009].

4.4.3. Food safety

Another difficulty that appeared during the testing phase was the decreased product durability, a challenge especially for the industrial products within the project “FOOD PRO-FIT”. Any product reformulation had to be reassessed using the HACCP-principles as the intrinsic physico-chemical properties were inevitably changed. One of the main consequences of reducing the fat and/or sugar content of foods is the altering in water activity: A decrease in fat level for instance can increase the moisture content resulting in a decreasing product pH. Potential food safety risks due to dietary

reformulation could be the consequence and the growth of undesirable germs may be supported [LÜFTENEGGER and ELMADFA, 2009; BETTS et al., 2006]: In the UK a reformulation-induced botulism outbreak after replacing added sugar by aspartame has been reported, but apart from that, information on reformulation induced risk for foodborne diseases is scarce. More studies on negative effects of food reformulations (including direct effects of alternative ingredients e.g. carcinogenic potential of artificial sweeteners) and risk-benefit analysis are required [SLEATOR and HILL, 2007].

Existing solution strategies for the potential food safety risk associated with reformulation like “hurdle technologies” are to compensate any decrease in preservation level due to sugar, salt or fat-reduction with other suitable factors used to control the growth of microorganisms: The factors to be considered include adjusted processing and chilling temperature (reduced storage temperature, increased heat process), reduced pH, preservatives (chemical additives) and the reduction of water activity <0.6 (water evaporated from a product or binding ingredients such as proteins, fats, sugars and salt). Moreover, modified atmosphere storage conditions (in order to reduce respiration and compositional changes) or other preservation techniques like ultrasound, high pressure or ultraviolet light can reduce the reformulation induced risk [BETTS et al., 2006; FND, 2010].

Although these methods could increase product durability, one has to ask whether the replacement of fat, sugar and salt by other nutrients/additives (e.g. preservatives, sweeteners) really results in a healthier product [VAN RAAIJ et al., 2008]. Moreover, as confirmed by the focus groups, consumers nowadays look for natural foods – increased levels of artificial compounds and chemical preservatives were therefore no option for most of the SMEs participating in the project “FOOD PRO-FIT”. They preferred the antimicrobial potential of natural ingredients like vegetable extracts, onion, horseradish and garlic, as well as mustard, herbs and spices in exchange for sodium and counted on qualitative changes in fat (SFAs replaced for MUFAs and PUFAs) and sugar (e.g. fructose sweeter than sucrose) [BETTS et al., 2006].

To conclude, recommendations of minimum achievable levels of saturated fat, sodium and/or total sugar levels in different products that still maintain the physical and microbiological quality are not possible. Generally there is no increased microbiological risk in heat treated products with reduced levels of fats and sugar. But it is necessary to assess the impact of recipe changes on each single product on an individual basis [LÜFTENEGGER and ELMADFA, 2009; BETTS et al., 2006].

Because of the limits already mentioned (safety risks, technological borders, legislative aspects etc.), it is easier to reformulate dishes than primary products. Although the overall aim of the HANCP concept was to reduce at least 50% of the excess of sodium, added sugar and SFAs in foods, many useful reformulations could occur without meeting the reduction limits fixed by the project consortium. Every reduction could contribute to an overall better diet: In the “Tick programme”, for instance, the total decrease in sodium was twice the reduction from reformulated products achieving the Tick approval [WILLIAMS et al., 2003].

4.4.4. HANCP computer application

In the course of the HANCP-testing it could also be shown that the analysis is only as good and accurate as the included **database**, a limitation that can only be partly attributed to the HANCP concept itself: Whereas the HANCP application includes a factor to correct for water evaporation (weight change in recipe due to cooking process, like yield factor), the nutrient retention factor is not yet part of the program. The more precise the combination of ingredients the better is the estimation of the real content of disease-related nutrients. Unfortunately, available food composition databases are not precise enough and often lack, for instance, data on natural and added sugars or different types of cooking and are far from complete. E.g. the underestimation of sodium using the German BLS is up to 40% and the total dietary intake is about 1.4 to 1.7 times higher than estimated [GROSSKLAUS et al., 2010]. Additional to the lack in the database, the food producers and providers in some cases failed to report on some qualitative data including the type and quantity of oil/fat, determination of gross or net weight and specification of the meat cuts as well as quantitative data (esp. exact amount of used salt). When obvious, the missing reported data was enquired of the enterprises to correct the information in the HANCP tool.

The risk assessment of foods was also complicated by the wide range of ingredients (including additives and condiments) used by food manufacturers and sometimes required laboratory nutritional analyses especially in the food industry [AUTONELL et al., 2010]. The lack of some foods, especially regional products, distorted the results of the calculations as available options had to be chosen and reduced the comparability between countries. Because of the lack of the German version of the EuroFIR database [EUROFIR, 2011], Germany also consulted the software DGE PC professional in addition

to the HANCP tool. Misclassification of foods and categorization of similar foods under generic denominations (e.g. different composition of similar products) did not allow the correct risk assessment of sodium, sugar and saturated fat in the course of the project. But the HANCP application should anyway be considered as “risk management tool”, helping SMEs to improve the nutritional quality of their foods, rather than as “risk assessment tool” [TETENS et al., 2007].

Another difficulty was that in the testing phase the **nutritional performance criteria (NPC)** were defined to reduce 50% of the excess **without taking the starting points into account**. The full reduction and reformulation potential was only tapped for those products and dishes containing higher amounts of undesired nutrients: Some enterprises could easily reduce more than 50% of the excess, whereas others with products almost in the range of the recommendations could not cut down on the nutrients of study any further. In order to portray the desired reduction success, SMEs could have manipulated the serving size or fixed higher starting points.

It is important for a successful evolution of the HANCP tool to include upper limits of nutrients for HANCP dishes and products (besides the FNOs and NPC), in order to allow consumers to estimate the amount of nutrients in the products and to find out whether the product really is a healthy option [EBC.Ltd, 2010]: The definition of “healthy” and “unhealthy” or “high or low amount of nutrients” depends on the comparison with standard foods: Although 50% of the excess in sodium, sugar or SFAs have been reduced and the new option is healthier compared to similar ones, the reformulated product might still include a considerable amount of these nutrients: E.g. a snack reduced in sodium is healthier than fully salted snacks but still remains a salty product [LOBSTEIN and DAVIES, 2008]. The “FOOD PRO-FIT” dishes and products were healthier options, but not necessarily healthy per se – a fact that could be misunderstood by consumers.

For the future, it is recommended to create a two-stage HANCP model: The basis defines the upper limits of nutrients to decide on the inclusion in the HANCP strategy (maximum starting points). Only products or dishes within these limits are allowed to get a certificate. In order to be allowed to promote the food with a “FOOD PRO-FIT Logo” in the next step, additional optimization and reformulation processes (actual HANCP concept including FNOs and NPC) have to be implemented [EBC.Ltd, 2010].

In usability tests and workshops in Spain, **additional areas for improvement** have been identified mainly affecting the visual part or front office (like including bigger

texts, a touch-screen version with illustrations and a virtual kitchen and the option to view information per serving). Moreover, it was suggested to add the variable “price” in future in order to allow the estimation of reformulation-induced price changes [AUTONELL et al., 2010].

4.4.5. Cost factor

Although not being one of the main criteria of the project “FOOD PRO-FIT”, the **cost factor** is without controversy one of the main criteria for enterprises to opt for healthier products and dishes and SMEs were sometimes sceptical to invest in innovation: The general economic crisis sometimes resulted in staff redundancy and limited the willingness to implement some reformulation proposals because of added costs and additional risks of introducing new products into the market [AUTONELL et al., 2010].

The necessary changes in food production are often very costly for the industry and the financial impact is enforced when consumers are not willing to buy the ameliorated products [PENNEY, 2009]. Of course, the simple reduction of ingredients (e.g. salt or sugar) would reduce the costs of a product or dish, but most of the time the exchange with other, more nutritive ingredients (e.g. herbs and spices, salt substitutes, wholemeal products) is more expensive as confirmed by several studies: Products and dishes with high portions of whole grains, vegetables, fruits and lean meat are associated with increased food costs (healthier market basket about 17-19% more expensive), since sugar is a very cheap source of energy [DREWNOWSKI, 2000; JETTER and CASSADY, 2006]. Healthy, nutrient-dense diets are generally more expensive when comparing the energy content. Whereas starches and grains are healthy options providing energy at a low cost (0.25€/MJ), most nutrient-dense foods like fruits and vegetables (8% of total dietary energy vs. 17% of total diet cost) or whole-wheat breads are associated with high costs. To save money, price differences depending on stores, season, origin, size, preparation etc. have to be recognized and economy-line products should be favoured over branded foods that are twice as expensive but not more nutritive [MAILLOT et al., 2007].

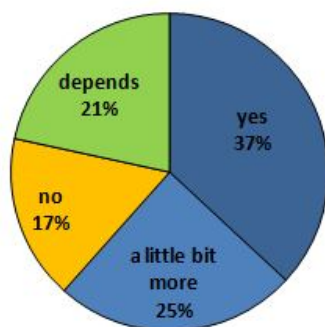
The majority of the stakeholders participating in the focus groups concluded that higher costs were inevitable in order to stay innovative and gain additional market shares, especially because of increased marketing and advertising efforts as well as the purchase of raw products of higher quality. Nevertheless, with the right choice of raw material (e.g. buying regional and seasonal products), public support and effective

partnerships healthier dishes and products do not have to be more expensive than standard ones.

People are very sensitive about price increases. Besides unavailability (obesogenic environment), high prices are among the most important constraints for consumers to eat healthily and choose healthier alternatives [JETTER and CASSADY, 2006]: Consumers in the focus groups stated that the price of a product or dish (cheap and fair prices or special offers) significantly influences their choice between healthy and unhealthy variants.

Fig. 15: Attitudes of German consumers on price policies
(n=1,000) [EBC.Ltd, 2010]

Would you be ready to pay more for healthier products?



Nevertheless, more than half of the 1,000 interviewed German customers stated to be ready to pay more for healthier dishes and products, only 17% would not do so (Fig.15) [EBC.Ltd, 2010].

Another consumer survey in Germany confirmed these results and revealed that 36% of 105 polled “FOOD PRO-FIT”-consumers would be willing to spend max. 1€ more for a reformulated dish, 13% would

accept an increase in price of 1.50€ and 11% – predominantly women – would pay additional 2€. Only 20% would not buy the “FOOD PRO-FIT” dish if it was more expensive [MENZE, 2009].

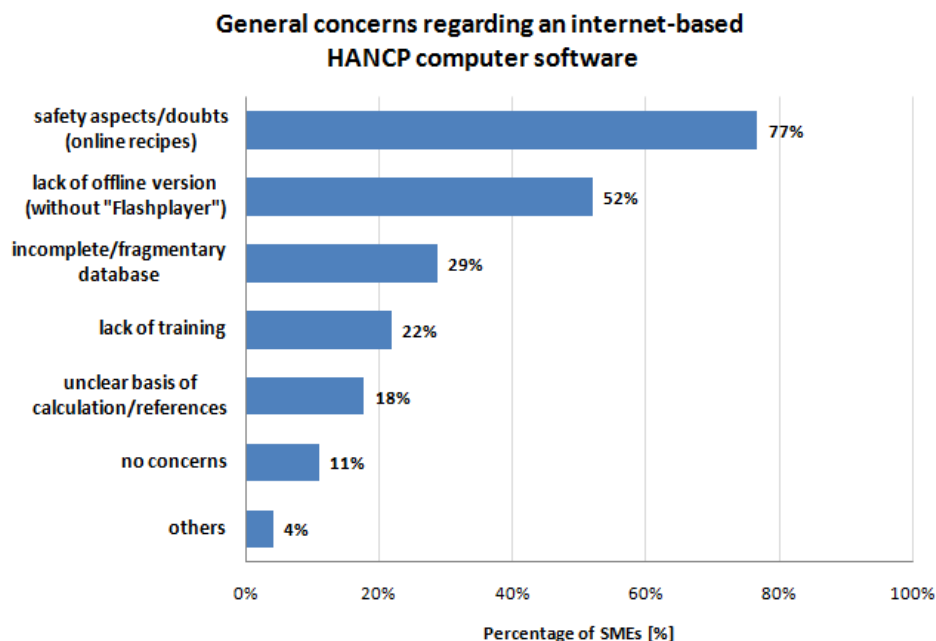
In order to get the interest of SMEs despite potentially increased production costs and to allay their financial doubts, the project “FOOD PRO-FIT” offered the enterprises to promote their products and dishes with a “FOOD PRO-FIT” logo and to profit from reformulated options with an advantage in the market due to actual health trends. The potential to advertise with the nutritional improvements was generally seen as incentive for innovation. Moreover, the “FOOD PRO-FIT” tool was a chance for SMEs to evaluate the nutritional risk of dishes and products at a glance without large investments in reformulation research, if they could not afford analysis. With a revised version of the HANCP tool, small sized enterprises with little resources could get an alternative to direct analysis. The computer application could provide guidance when

and to what extent the reformulation could change the dietary quality and help SMEs to stay competitive on the market promoting and protecting innovative processes.

4.4.6. SMEs

The main obstacles and challenges when seeking to win SMEs for the introduction of new methods or processes like the HANCP tool were limited resources (probable high costs of innovations, reformulations), language barriers, lack of trust (safety concern “Flash player”: enterprises did not want to include their recipes in the online HANCP tool), lack of skills (few employees with nutrition education or know-how) and time restriction. Minor reasons not to participate in the project were the missing relevance for the enterprise (e.g. already healthy enough) or the production of unchangeable dishes or products (Fig. 16 and Fig. 17) [EBC.Ltd, 2010].

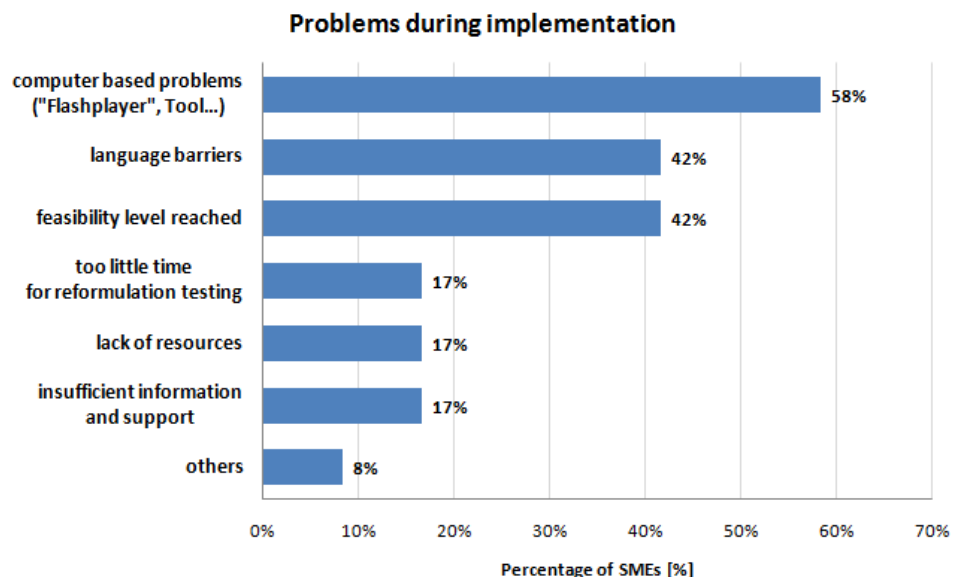
Fig. 16: German survey among SMEs – “What general concerns do you have regarding the use of an internet-based HANCP computer software?” (Several choices possible), *n*=73 [EBC.Ltd, 2010]



Being one of the largest manufacturing sectors in Europe, the food sector had an annual sales volume of over 800 billion Euros in 2006. 99% of food producers are small and medium sized enterprises with little or any research and development activities. Large companies have without any doubt an advantage over small and medium sized enterprises in having the know-how, technological options, resources and specialists to provide guidance and help to reformulate food production concepts [BRAUN, 2008].

The drive to reformulate depends on the size of an enterprise. In other words, big enterprises are much more likely to reformulate their products (82% in 2008) compared to SMEs (27%) [CIAA, 2010].

Fig. 17: German survey among SMEs – “What problems have occurred concerning the implementation of the project FOOD PRO-FIT?” (Several choices possible), n=12 (participating in pilot phase) [EBC.Ltd, 2010]



Therefore, the collaboration with local authorities (e.g. Ministry of Health and Consume of the Balearic Islands) and experts (e.g. Gercid in Germany) and the interaction with the SMEs on a common ground were crucial strategies for the success of the pilot project.

4.5. Benefits and strengths

4.5.1. Innovative self-evaluation concept

Despite these difficulties that could be solved when respecting some aspects and the ideas for improvement, the HANCP tool has great potential: The HANCP computer application is an innovative self-evaluation tool that adapts to current and future needs. The strength of the concept lies within the *combination of recommendations, evaluation strategies and reformulation* of the product that improves the nutritional quality of foods, leading to a greater choice of healthy foods and hopefully to an overall better diet. Via the free accessible web2.0 area www.hancptool.org, that was

monitored by Google analytics [GOOGLE, 2011], interested enterprises profited from the interactive computer application providing them with an innovative health technology approach and thereby almost independently improved the nutritional quality of their products and dishes [AUTONELL et al., 2010]. The aim of the HANCP concept was not to punish food companies providing foods high in SFAs, sodium or sugar, but to stimulate innovation processes and to encourage SMEs to voluntarily assess the nutritional risk of their products as well as to reformulate them if necessary in order to create healthier options.

The innovative e-health and “apomediation” concept HANCP allows SMEs to stay competitive via modern strategies of health and safety management and to profit from interactive relationship and communication without depending on lots of resources and know-how on the server web 2.0. “Apomediation” means that food producers and providers are no longer reliant on health professionals to provide information and guidance in the first place. Furthermore, SMEs are enabled to autonomously improve the quality of their foods – only guided by the HANCP tool. The project “FOOD PROFIT” started to create a network of efficiency where SMEs can share their knowledge and experience on reformulation processes and profit from reformulated ingredients as bases for improved dishes or products [EYSENBACH, 2008; AUTONELL et al., 2010].

4.5.2. Combination of essential qualities

The HANCP tool combines qualities that are essential for nutrient profiling schemes [GARSETTI et al., 2007]: The tool is rather easy to use, based on scientific evidence and able to cope with possible changes in nutrient recommendations.

The nutritional risk of potential “unhealthy” foods can be assessed at a glance. The focus in the pilot phase on only three nutrients – the disease-related nutrients Na, added sugar and SFAs – as well as the independent conclusions about each nutrient, facilitated the learning processes for SMEs. The translation of the already simplified risk calculations into an independent computer application enables users to work on demanding, scientific aspects of health promotion and implement the HANCP tool without requiring specific know-how or technical skills, except for simple knowledge in nutrition and food production. The computer application allows in a rapid and convenient manner to evaluate the nutritional quality of dishes and products and to simulate effects of reformulation processes on the final product.

The relevant rationale of the “FOOD PRO-FIT” concept was built upon a solid scientific basis combining data on dietary intake and food composition with meaningful, science-based nutrition policy objectives and population nutrient intake goals. The HANCP approach was linked to actual dietary recommendations, but with being a flexible and dynamic tool the system can easily be revised and changed as soon as new scientific knowledge emerges [GARSETTI et al., 2007; OBERDÖRFER et al., 2007].

4.5.3. Impact level

Although it was not feasible to reformulate all dishes and products and reduce the amount of disease-related nutrients to the level recommended by the HANCP tool, the general risk could be decreased compared to the original food. Results from the Balearic pilot showed that the average nutritional risk reduction for 100g of reformulated recipe in the HORECA food service channel was 2.8g of SFAs, 6.6g of free sugar and 83.2mg of Na or 0.2g salt (Fig.18). If an average recipe is considered, then, in a serving of the reformulated recipe (average servings of 300g of savoury dishes and 200g of desserts), there would be a reduction of 2.8% and 2.6% of energy from SFAs and sugars respectively for a person with an average requirement of 2000kcal. The contribution of sodium would be reduced by almost 250mg per day (most impact), which corresponds to 10% of the recommended daily intake of 2,400mg of sodium per day (Fig.19) [AUTONELL et al., 2010].

Fig. 18: Average reduction of nutritional risk for 100g of reformulated food [AUTONELL et al., 2010]

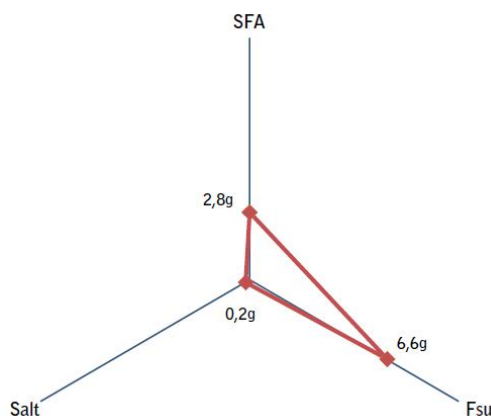
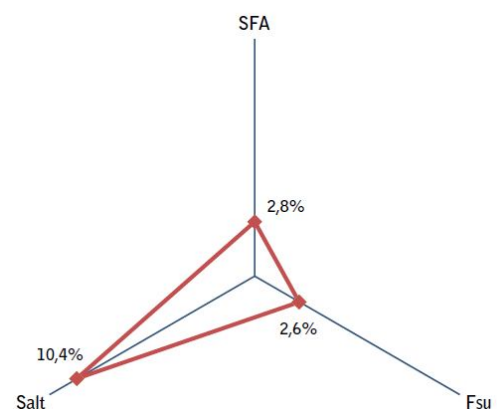


Fig. 19: Average reduction of nutritional risk in an average diet by eating a reformulated dish (2,000 kcal/day) [AUTONELL et al., 2010]



The HORECA sector profited from the HANCP to a large extent: Participating restaurants, caterers and hotel managers could apply the computer application with great agility. They became aware of the nutritional risks and the potential of improving the nutritional profile of their dishes, taking the innovative concepts (including proposals for nutritional claims) as chance to compete in the food sector [AUTONELL et al., 2010].

The usability of the HANCP tool in the industry was limited and the reformulation processes were more challenging for industrial SMEs than for the HORECA sector due to additional requirements for the products including longer shelf-life or legislative limitations. Nevertheless, the SMEs from industry appreciated the HANCP tool for discovering the potential competitive value of reformulated products against the original and most of them were ambitious to reduce the amounts of the nutrients under study as far as possible. The successful reduction of 5.7g added sugar and 380mg of sodium in 100g reformulated ice-creams, sausages or cheese resulted in 1.1% and 16% reduction of sugar and sodium in an average diet including 100g of the optimized versions. These reformulation successes of Spanish SMEs participating in the project would amount for 1.7t sugar (6.8 million kcal) and 4.7t salt per year, being removed from the human diet [AUTONELL et al., 2010].

4.5.4. Consumer acceptance

Although the project “FOOD PRO-FIT” was mainly directed at SMEs in order to improve the quality of food, it also aimed at ameliorating the diet quality of consumers by providing them with healthier choices.

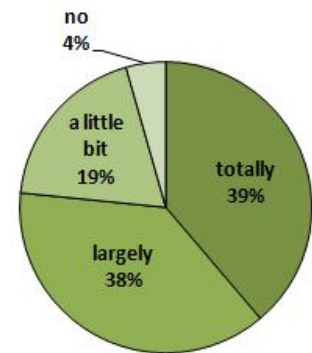
A consumer survey conducted in the **Balearic Islands** could show that the “FOOD PRO-FIT” initiative was well-graded by customers: 80% of the consumers thought the idea of the project was good or very good. About 56% of the interviewed customers chose an option within the reformulated buffet and 85% liked it very much or thought it was ok. The vast majority (84%) would choose an establishment offering an initiative to improve the nutritional quality of foods, but 35% would only do so on the condition that the price would be maintained [AUTONELL et al., 2010].

Similar results could be shown by various “FOOD PRO-FIT”-surveys in **Germany**: 33% of the SMEs participating in the German pilot phase (n=12) stated that their collaboration in the project and the reformulated products brought about a positive

response (58% did not know about their clients' acceptance and only 8% got mixed feedback) [EBC.Ltd, 2010].

Consumers welcomed the concept of HANCP and were generally satisfied with the new products and dishes. More than 70% of costumers who have been interviewed on the project "FOOD PRO-FIT" (n=1,000) totally or largely agreed with the project idea of reformulating foods to improve the diet quality in Europe (39% and 38% respectively, Fig. 20) and 62% thought that food producers and caterers are responsible for the health of their clients. 148 consumers had already tried a reformulated product and 34% thought it tasted even better than the original. Only 3% were not satisfied and thought it was worse than the standard version. 57% of the polled consumers will carry on buying optimised dishes and products in the future and 69% would prefer even a bigger range of such options on the market [EBC.Ltd, 2010].

Fig. 20: Consumer survey – "Do you agree with the project idea of healthier food?" n=1,000 [EBC.Ltd, 2010]



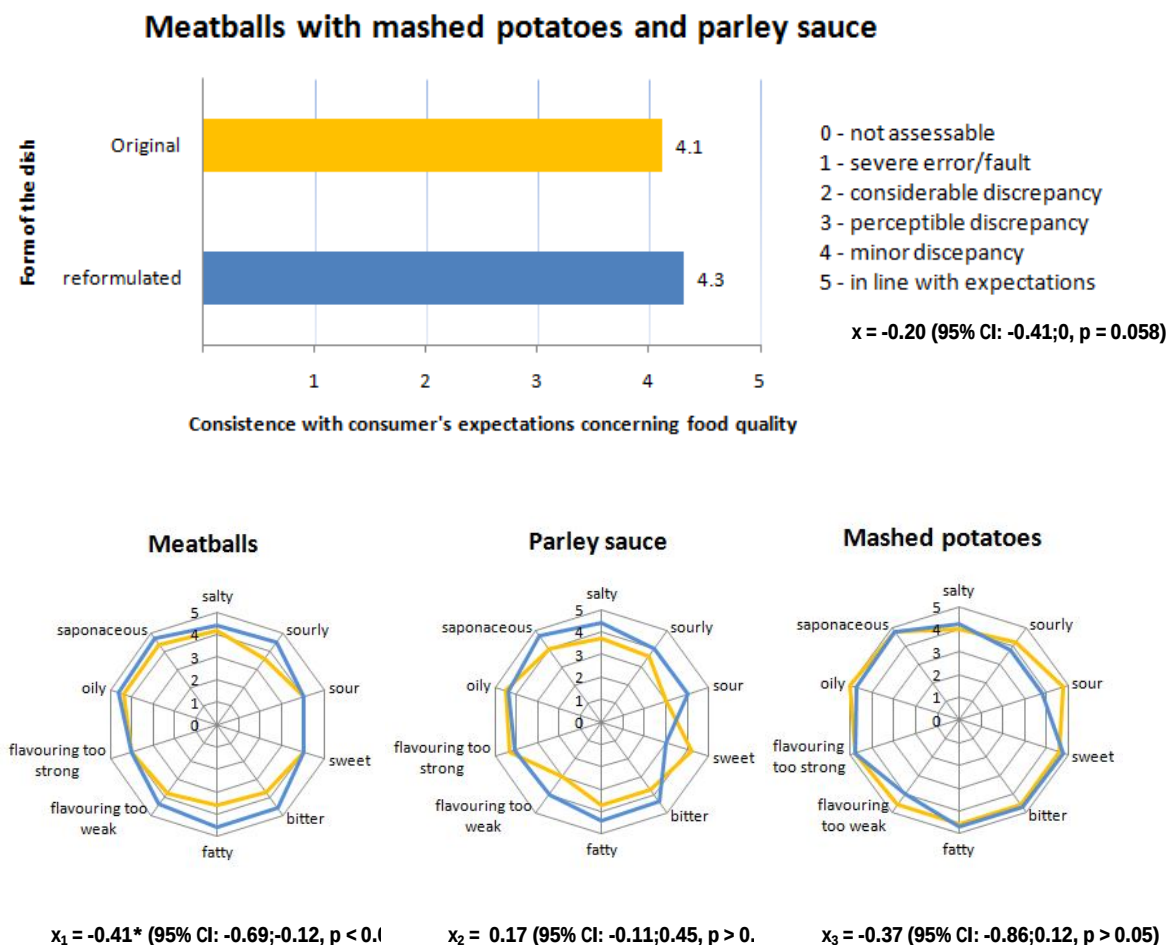
In a **German canteen** participating in the pilot phase of the project, the HANCP controlled and optimized version was often among the most frequently sold dishes: Among 250 provided meals a day (14.05.2009) from 5 choices, the reformulated "escalope chasseur" (47% reduction in SFAs and 14% less Na) was chosen 71 times, making it the "top seller" of the day (28%). The "FOOD PRO-FIT" dish stood up to spinach-pasta (20%), steamed turkey with cream of asparagus (23%), "Pichelsteiner stew" (9%) and sheep provincial (20%). Meatballs with mushroom sauce and wholegrain pasta" (90% reduction of SFAs) came second being sold 71 times out of 243 [EBC.Ltd, 2010].

In another consumer survey which focused on the acceptance of the HANCP dishes in this canteen (n=105), mere chance, personal preferences as well as health aspects (more important with age) were stated as the main reasons for selecting a reformulated "FOOD PRO-FIT" dish (40%, 29% and 20%, respectively). 65% of the costumers looked positively on the reformulated options and 15% even favoured and up-rated the optimized dish. 55% liked the flavour of the product and for 17% the "FOOD PRO-FIT" version tasted very good. Providing the consumers with tasteful reformulated dishes confirmed the hypothesis that healthy options could be as delicious as the traditional one. About one third of the consumers stated that the

“FOOD PRO-FIT” dish indeed tasted differently compared with the original but not worse. The majority of respondents did not correct the seasoning whereas 20% added salt or pepper to the dish. In this survey, almost 80% of the consumers in Germany welcomed the “FOOD PRO-FIT” strategy and agreed with the Spanish respondents that the idea of the project was good or even very good, among women the acceptance was highest [MENZE, 2009].

In a preference testing with paired cross-validation the participants were asked to rate ten sensory properties (including taste, smell and visual effects) on a hedonic scale from 0-5 based on personal expectations, a score of 0 representing “not assessable” and 5 representing “in line with expectations”. In some cases the reformulated product was even favoured over the original one, as can be seen with “meatballs” from the example in Fig.21 [MENZE, 2009]. The HANCP tool has great potential to result in improved and healthier foods in line with consumer needs and expectations.

Fig. 21: Preference testing of a reformulated German dish, $n = 7$ [modified: MENZE, 2009]



4.5.5. Acceptance among SMEs and GOOGLE ANALYTICS results

Evidence from former projects and studies suggests prejudices of food producers and caterers against healthy diets – often describing them as “being less appealing, bland and with little taste”. Participants in the focus groups expressed a need to allow SMEs to quickly check the individual risk of their products and would welcome training to create tasty, healthy foods.

The aim of the project “FOOD PRO-FIT” therefore was to raise the awareness not only in the public, but also to target the staff of the food manufacturing and service sector and to make them aware of the potential and importance of healthy products and dishes as well as to help them to provide tasty, healthier options for consumers [AUTONELL et al., 2010].

According to the survey among German SMEs (n=73), more than 80% of food producers and caterers think that health-relevant food optimisation is important or very important (Fig.22). In their opinion, potential fields of application for the HANCP tool mainly lie within the identification of potential candidates for reformulation, the improvement of recipes as well as the evaluation and validation of the results (Fig.23). 14% of the SMEs would welcome the idea to evolve the HANCP concept into a national or even international standard and 55% think this evolution could probably be useful [EBC.Ltd, 2010].

Fig. 22: Survey among SMEs – “What do you think of the idea of health-relevant food optimization?”, n=73 [EBC.Ltd, 2010]

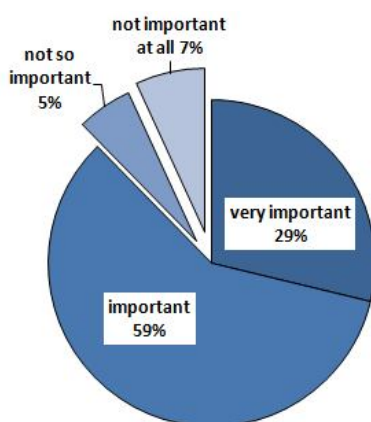
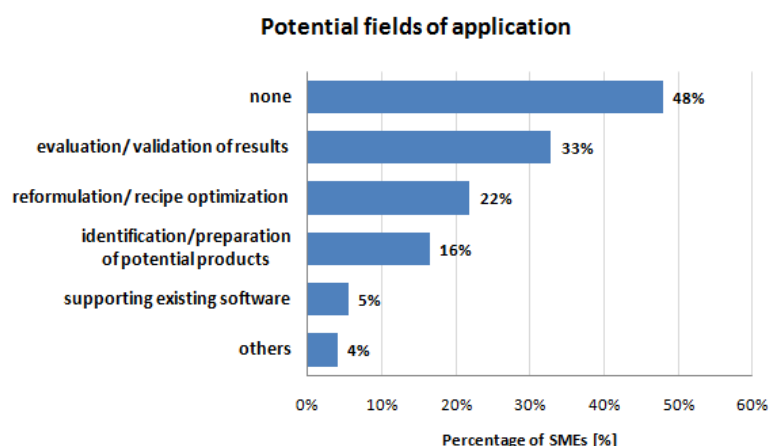
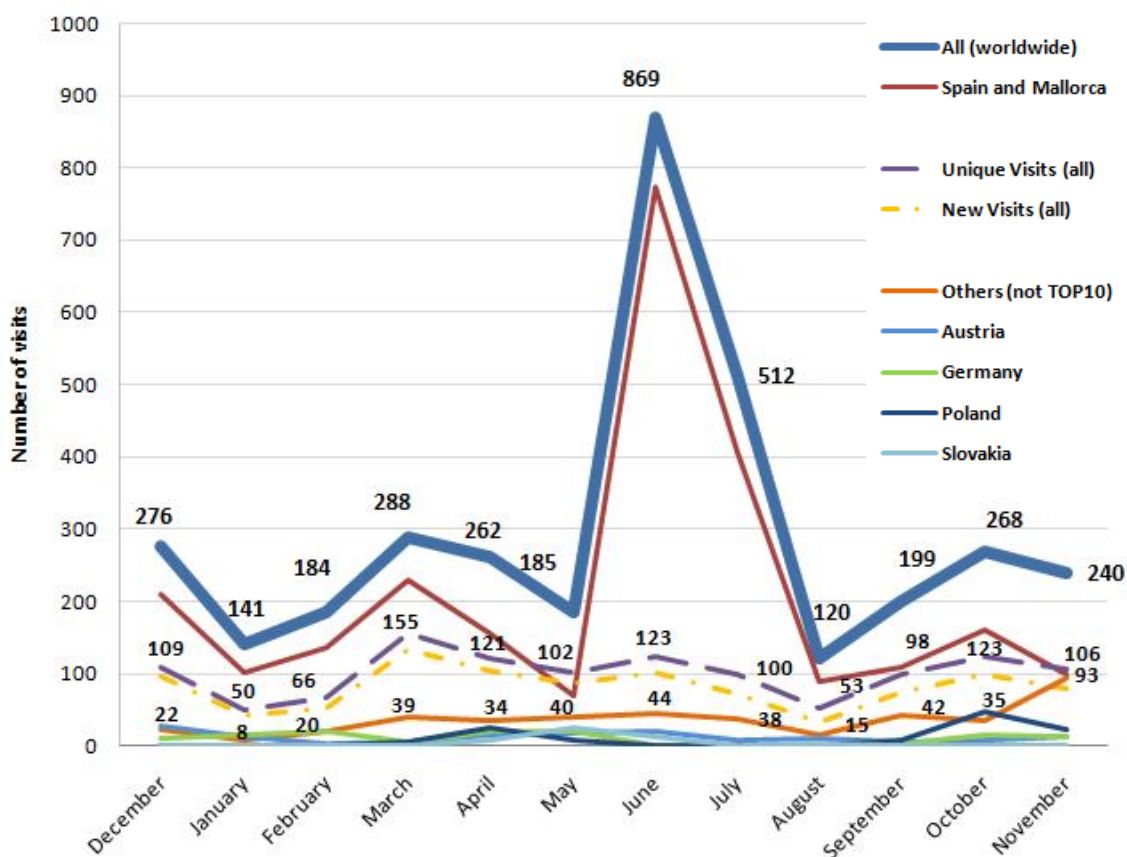


Fig. 23: Survey among SMEs – “What are potential fields of application for the HANCP tool?” (Several choices possible), n=73 [EBC.Ltd, 2010]



The level of acceptance within the participating SMEs was good and the HANCP tool was used regularly, as can be seen from the Google analytics results within one year (Fig. 24). All of them were interested in the HANCP concept and sensitive concerning their role in the population's health. About 80% of the users were located in Spain thanks to a very successful dissemination strategy of the two Spanish partners, the Regional Ministry of Health of the Balearic Islands and the Hotel Faculty of the Balearic Islands. Although several logins might be due to administration and work on the tool in the Spanish countries, the results suggest that best results can be obtained when there is active participation of communities, politicians, health systems, as well as the food industries.

Fig. 24: Number of absolute and unique visits of www.hancptool.org in Europe from Dec.'09 to Nov.'10 (Raw data from Google analytics [GOOGLE, 2011])



Moreover, the testing phase showed that the tool is quite easy to understand for most of the enterprises and that only basic knowledge in nutrition as well as cooking skills are needed to handle the computer application. After a short briefing and with

the help of online tutorial videos, users easily comprehended how to use the HANCP computer application the first time and could effectively include recipes, assess the risk and reformulate the recipe online (Fig. 25 and 26). The steps were easy to remember and only little technical know-how was necessary.

Fig. 25: Successful logins to the HANCP website from Dec.'09 to Nov. '10 (Raw data from Google analytics [GOOGLE, 2011])

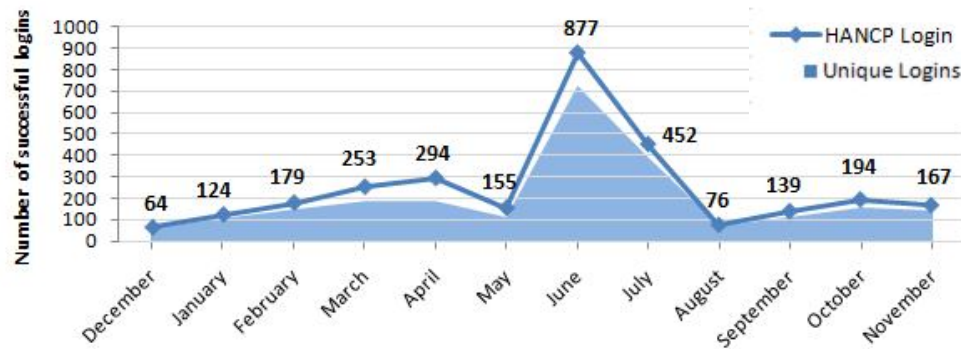


Fig. 26: Frequency of use of the "Recipe Section" within the HANCP-tool from Dec.'09 to Nov. '10 (Raw data from Google analytics [GOOGLE, 2011])

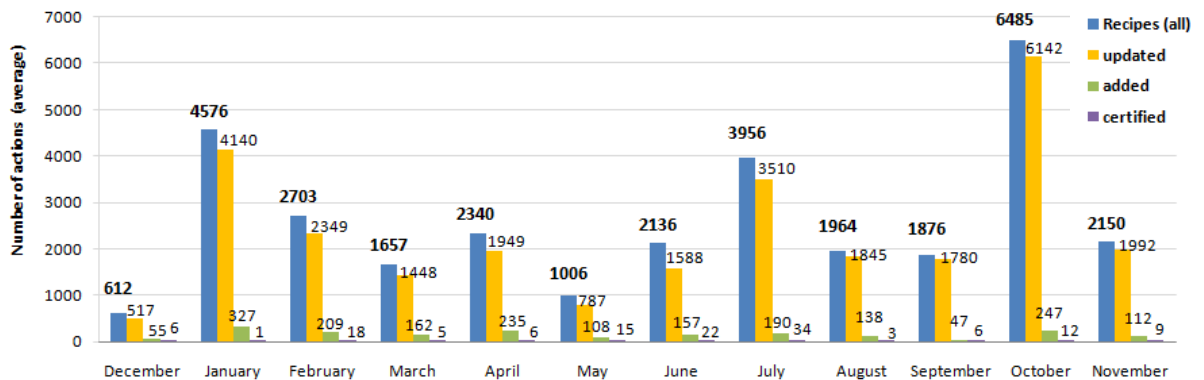
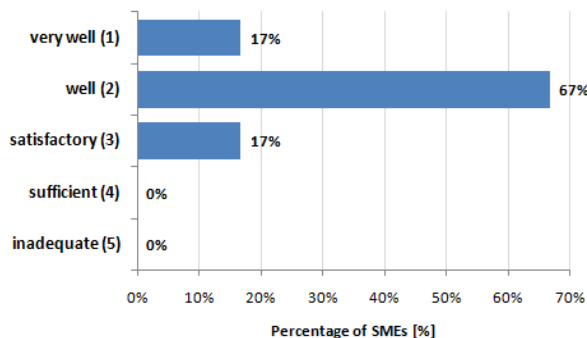


Fig. 27: Survey among SMEs – "How do you rate the technical and organizational support during the project?", n=12 [EBC.Ltd, 2010]



Most users felt very positive about their experience with the HANCP tool and the participating SMEs were generally satisfied with the technical and organizational support during the project (Fig.27).

The HANCP tool was seen as potential alternative to expensive food analysis especially for small enterprises: Most of the SMEs lack expertise and resources in order to obtain information on the nutrient content necessary for declarations and to improve the quality of their products and dishes. Supported by the HANCP computer application, food producers and providers get the chance to find out about potential nutritional claims to promote their products and dishes and thereby to assert an innovative and competitive position on the market.

About 2,000 added recipes (Table 23) and about 3,600 visits (Table 24) within one year show that the implementation of the HANCP tool in small and medium sized enterprises was very successful and strengthen its importance as a new tool to improve the diet quality in Europe.

Table 23: Frequency of use of the “Recipe Section” within the HANCP-tool from Dec.’09 to Nov.’10 (Raw data from Google analytics [GOOGLE, 2011])

	All visits
Recipes (all actions)	31,461
updated	28,047
added	1,987
certified	137

Moreover, the logins and reformulation attempts did not only come from the “FOOD PRO-FIT” partner countries but also other countries within Europe and even other continents. Thanks to several national and international dissemination strategies, the HANCP tool has been popularized almost all over the world (Fig. 28-30 and Table 24). This spread of the HANCP concept and tool could also lead to more *transparency and traceability* in the food chain, especially in small and medium sized enterprises.

Fig. 28: Distribution of visits of the HANCP-tool all over the world dyed green (43 countries) from Dec.’09 to Nov.’10 [GOOGLE, 2011]



Fig. 29: Distribution of visits per city of the HANCP-tool all over the world in orange (217 cities) from Dec.’09 to Nov.’10 [GOOGLE, 2011]



Fig. 30: Visits of the HANCP website per city and country from Dec.'09 to Nov.'10 (Raw data from Google analytics [GOOGLE, 2011])

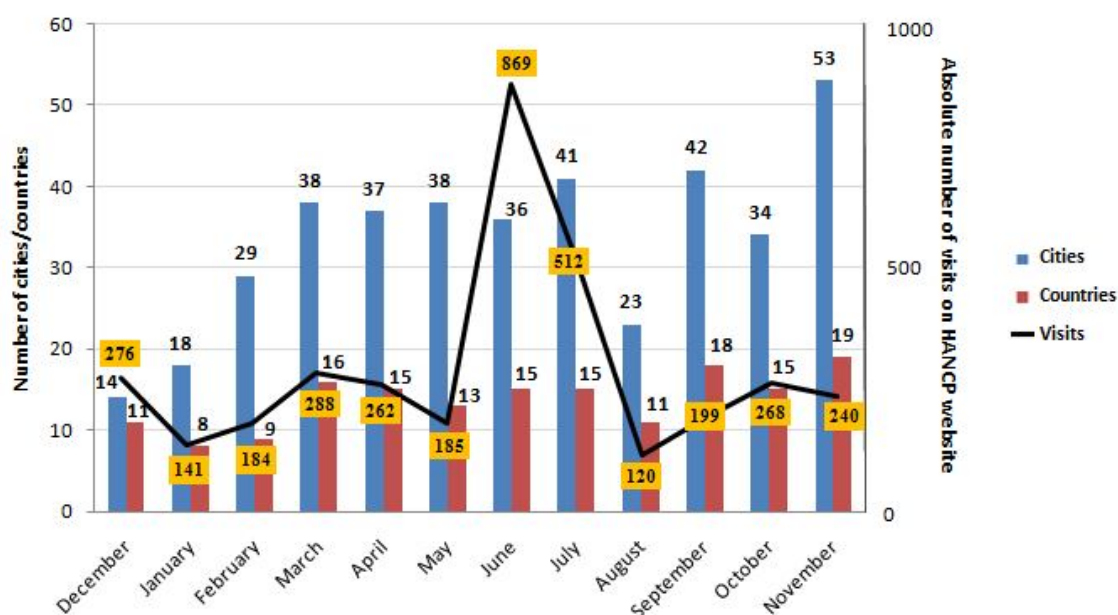


Table 24: Details on visits per country (Top 10) from Dec.'09 to Nov.'10 (Raw data from Google analytics [GOOGLE, 2011])

TOP TEN VISITING COUNTRIES 1 st of NOV 2009 – 30 th of NOV 2010 43 countries, 217 cities						
	Visits	Page/Visit	Time on site [min]	New Visits [%]	New Visits	Bounce Rate [%]
1. Spain	2,716	3.2	14	24	658	9.7
2. Germany	170	2.9	35	25	43	12.9
3. Austria	152	4.8	13	33	50	18.4
4. Poland	131	3.4	17	34	45	12.2
5. Greece	119	3.7	20	39	46	15.1
6. Slovakia	55	7.6	10	40	22	5.5
7. France	55	4.1	3	49	27	38.2
8. United States	24	3.3	11	54	13	25.0
9. Belgium	21	4.5	2	52	11	33.3
10. United Kingdom	17	5.7	8	71	12	5.9
Others (not Top10)	160				50	
All	3,620	3.5	14	27	977	10.0

Concerning the **sustainability of the project “FOOD PRO-FIT”**, the HANCP computer application is open for extension and very flexible, so more nutrients could be included to be evaluated. In the future a more holistic approach could be considered and with the analysis of the overall nutrition profile of a dish or product or even whole diets, further health benefits could be achieved. The aim is to improve the quality of the traditional, daily diet without creating and applying new dietary or “light” versions but by making qualitative, nutritional changes in existing meals maintaining sensory properties and individual preferences [AUTONELL et al., 2010]. Moreover, the cumulative effect, also of small reductions, could overall lead to a large impact on the nutrient intake.

Nevertheless, one should always keep in mind that technical tools like HANCP or others can only assist in the comparison of the impact of various reformulations on nutritional quality and help with decisions, whether changes are worthwhile or not [LABOUZE et al., 2007]. The implementation of the changes is down to the enterprises. To control the evolution of the HANCP concept and the influence on the diet quality in Europe, there should be further investigations on the health impact assessment.

5. CONCLUSIONS

Perceptions of consumers and SMEs. Proposing foods with positive health effects is a very relevant topic nowadays. The results from the questionnaire-based preliminary study conducted within the project “FOOD PRO-FIT” strengthen the relevance of finding new ways to improve the diet quality in Europe.

The awareness of consumers and enterprises concerning health issues is increasing: A trend towards rising interest in diet-related diseases and the importance of improving food nutritional characteristics and food habits can be seen: The quality of food is considered to be one of the most important determinants of health for consumers. Especially foods with low fat, sugar and sodium contents are perceived as “healthy” [ASRD, 2008]. Besides the content of these nutrients in the food products, the main determinants that influence the food choice include the freshness and appearance of the product as well as its effect on disease prevention or the healing process.

The lacking availability and accessibility of healthy foods low in sugar/salt/SFAs (environmental factor) is blamed likewise by consumers and food producers and providers as one of the main reasons for overweight and obesity. In order to cope with chronic NCDs and to improve the diet quality in Europe, SMEs and HORECAs agree with nutritionists that effective strategies have to include the intense cooperation of industry, scientific organizations and public authorities and the provision of affordable, healthier meals in adequate portions.

Relevance and usability of the HANCP tool. A software providing such innovative and new prevention strategies for diet-related NCDs like the HANCP tool is strongly desired by enterprises and needed on the market.

The first reformulations with the HANCP-tool were mainly successful and the feedback of consumers was predominantly positive: Consumers welcomed the concept of HANCP and were generally satisfied with the new products and dishes; some of them even thought the reformulated product was better than the original one. Many consumers would also accept to pay more for “FOOD PRO-FIT” foods [EBC.Ltd, 2010; AUTONELL et al., 2010].

The HANCP computer application has great potential to adapt the food production process to the current expectations and needs of consumers. Stimulating

reformulation processes will broaden the choice of healthy products for citizens and is expected to lead to positive changes in eating habits.

Furthermore, it can strengthen the innovation process in Europe except for some special limitations: The potential of this computer application mainly lies within the HORECA sector because of legislative, technological and safety-related borders in the reformulation of some industrial food products. Besides legislative limitations, technological difficulties, decreased product durability and safety risks, other obstacles comprising limited resources, language barriers, lack of skills and time restriction impeded the implementation. Most of these difficulties could be solved when respecting some aspects and the ideas for improvement. Many useful reformulations could also occur without entirely meeting the reduction limits fixed by the project consortium and resulted in healthier options. Every reduction could contribute to an overall better diet.

After improvement measurements according to the suggestions of SMEs, project partners and experts, the HANCP tool could have a significant positive impact on public health in Europe, when being implemented by all food enterprises. With nearly four thousand visitors from over 40 countries, the tool <http://hancptool.org> can be sustainable – it could evolve into a worldwide measurement tool for the health impact of reformulating food products into healthier versions.

Whether the pilot project “FOOD PRO-FIT” is able to have a long-term impact on the development of non-communicable chronic diseases cannot be said by now. The HANCP tool is already capable of bringing more transparency and reliability into every step of the food chain of small and medium-sized enterprises and probably to increase the knowledge and awareness on healthier lifestyle of both enterprises and consumers. But it is necessary to do a follow up evaluation study and to check the health impact after about one year.

In the past, voluntary actions to improve the diet quality and health in Europe often failed because of lacking sustainability and long-term compliance of the enterprises. Experience has shown that “self-regulations” are only effective in a very limited way: Despite the initial success and desired implementations in the beginning, many enterprises return to classical production processes some time after the end of the project. Probably, public pressure and legislative measurements including strict control and condign punishment for non-compliance like in Finland, could finally help to get the daily intakes of sodium, SFAs and added sugar in line with actual recommendations and to improve the diet quality in Europe [WAGNER, 2005].

6. SUMMARY

In view of the worldwide burden of chronic non-communicable diseases, new effective prevention techniques establishing health-supporting environments are needed. These strategies should support the availability and accessibility of healthy, nutritious foods and promote the reformulation of foods with nutrients associated with negative effects on health. In this regard, research has highlighted the following three nutrients: saturated fatty acids (SFAs), sodium (Na) and added sugar. There are already several approaches to deal with the rising prevalence of NCDs which target on a reduction of these so-called “disease-related nutrients”, but despite diverse recommendations and actions their intake is still too high in most European countries.

The European pilot project “FOOD PRO-FIT” (2006 340), conducted in seven European countries (Spain, Austria, Cyprus, Germany, Greece, Poland and Slovakia) from Nov. 2007 to Dec. 2010, therefore aimed to combine the most promising parts of existing strategies in a new, innovative approach involving small and medium sized enterprises (SMEs), health professionals and researchers to improve the nutritional quality of food products and dishes. After the assessment of the knowledge and perceptions of companies and consumers on “healthy food” via questionnaires and focus groups, that strengthened the importance of the project’s aims, and the identification of the main sources of the three disease-related nutrients, appropriate targets for reduction were defined. The existing food quality-management system HACCP was extended by including nutritional criteria (NCP) in the value chain of food production and preparation, resulting in the so-called “Hazard Analysis and Nutritional Control Points”: The food nutritional objectives (FNOs) were applied according to the recommendations of WHO from 2003 and EURODIET from 2000 and set the benchmarks for SFAs and added sugar at $\leq 10\%E$, for Na at $\leq 500\text{mg}/100\text{g}$ of food. The nutritional performance criteria (NPC) required from enterprises to reduce at least 50% of the excess. The developed HANCP computer application, a free accessible web2.0 self-evaluation tool monitored by Google analytics, provided interested enterprises with an easy to use, innovative health technology approach based on scientific evidence to put the reformulations into practice and improve the nutritional quality of their products and dishes almost on their own.

The aim of the project “FOOD PRO-FIT” was not to develop new technological strategies but, together with the SMEs, to test the feasibility of simple, existing strategies to reduce the amount of the nutrients under study by building on

experiences and successful reductions. The calculated potential impact of the HANCP concept by statistical modelling of Austrian food consumption and composition data suggested that about 30% of SFAs, 22% of sugar and 6% of sodium could theoretically be removed from the average Austrian diet by reformulation of the food groups that explain most of the observed variability in nutrient intake. In the case of Na and SFAs these food groups included primarily composite meals followed by meat and meat products as well as dairy products. Non-alcoholic drinks, soft drinks, fruit juices and sweets were the main food groups providing sugar.

The reformulations of more than 200 dishes and products with the HANCP-tool, conducted in the pilot countries Spain and Germany in collaboration with 14 hotels, restaurants and caterers and 16 enterprises from the industry, were quite successful in reducing the content of sodium, sugar and saturated fatty acids while maintaining the taste and characteristics expected by the consumers. The majority of consumers welcomed the concept of HANCP and was generally satisfied with the new products and dishes. Only in some special cases limits for the reformulation, especially for industrial products, could be shown during the pilot phase of the project: legislative limitations, technological borders, decreased product durability and safety risks. Other obstacles comprised limited resources, language barriers, lack of skills and time restriction. Nevertheless, many useful reformulations could also be achieved although not entirely meeting the reduction limits fixed by the project consortium.

To conclude, the HANCP tool met the demand of companies to quickly check the individual risk of their food products and dishes and was seen as a potential alternative to expensive food analysis, especially for small enterprises. Most users felt very positive about their experience with the HANCP tool. Supported by the HANCP computer application, food producers and providers got the chance to find out about potential nutritional claims to promote their products, a fact which could lead to an innovative image and a competitive position on the market. The level of acceptance within the participating SMEs was good and the HANCP tool was used regularly, as could be seen from the Google analytics results within one year: About 3,600 visits worldwide, not only from partner countries, and around 2,000 added recipes within one year emphasized the implementation success of the HANCP tool and strengthened its importance as a new tool to improve the diet quality in Europe.

7. ZUSAMMENFASSUNG

Angesichts der zunehmenden Belastung durch chronische, ernährungsbedingte Erkrankungen verstärken Gesundheitsexperten ihre Bemühungen auf der Suche nach wirksamen Präventionsmaßnahmen. Die Verbesserung der Verfügbarkeit von gesunden, nährstoffreichen Lebensmitteln und die Limitierung von unerwünschten Nährstoffen sollten hierbei im Vordergrund stehen. Als sogenannte „Risikonährstoffe“ werden häufig gesättigte Fettsäuren (GFS), Natrium (Na) und zugesetzter Zucker genannt. Viele Strategien bemühen sich bereits um eine Reduktion dieser „krankheitsbezogenen Nährstoffe“, dennoch liegt die tägliche Zufuhr an GFS, Na und Zucker in den meisten europäischen Ländern immer noch deutlich über den diversen Empfehlungen.

Das europäische Pilotprojekt „FOOD PRO-FIT“ (2006 340), das von Nov. 2007 bis Dez. 2010 in sieben europäischen Ländern durchgeführt wurde (Spanien, Österreich, Zypern, Deutschland, Griechenland, Polen und Slowakei), beabsichtigte daher, die vielversprechendsten Aspekte aus den verschiedenen existierenden Maßnahmen zu kombinieren. In einem neuen, innovativen Ansatz sollten Klein- und Mittelbetriebe (KMBs) in Zusammenarbeit mit Gesundheitsexperten und Wissenschaftlern Maßnahmen entwickeln und testen, um die Nährstoffqualität ihrer Produkte und Gerichte zu verbessern.

Nach Erhebung des Ernährungsbewusstseins bei Unternehmern und Konsumenten mithilfe von Fragebögen und der Auflistung der Hauptquellen für Zucker, Na und GFS, wurden vom Projektkonsortium entsprechende Ziele definiert. Das bestehende Hygienekonzept HACCP wurde um Ernährungsaspekte („NCPs“) erweitert und fand als sogenanntes HANCP-Konzept (Hazard Analysis and Nutritional Control Points) im Projekt Anwendung: Die Obergrenzen für die verschiedenen Nährstoffe („FNOs“) wurden entsprechend der Empfehlungen der WHO von 2003 und EURODIET aus dem Jahr 2000 auf $\leq 10\%$ für GFS und Zucker sowie $\leq 500\text{mg Na}/100\text{g Lebensmittel}$ festgelegt. Die angestrebten Reduktionsgrenzen („NPCs“) erfordern von den Betrieben eine mindestens 50%ige Reduktion des bestehenden Überschusses an den Risikonährstoffen. Mithilfe der entwickelten HANCP-Computeranwendung, einem freizugänglichen, innovativen, wissenschaftlich fundierten Web2.0-Programm, war es den Unternehmen möglich, die Nährstoffqualität ihrer Produkte und Gerichte beinahe vollkommen selbstständig zu verbessern.

Das Ziel des Projektes „FOOD PRO-FIT“ lag dabei nicht in der Entwicklung neuer technologischer Produktionsstrategien, sondern dem Aufbau auf Erfahrungen sowie der Anwendung und dem Testen einfacher, bestehender Reduktionsmaßnahmen. Eine statistische Abschätzung des möglichen Potentials des HANCP-Konzeptes am Beispiel österreichischer Verzehrdaten ergab, dass theoretisch etwa 30% der GFS, 22% des Zuckers sowie 6% des Natriums aus der Ernährung der ÖsterreicherInnen entfernt werden könnten. Vor allem Fertiggerichte, Fleisch- und Milchprodukte (im Fall von Na und GFS) sowie Nichtalkoholische Getränke/Softdrinks/Fruchtsäfte, Süßigkeiten und Mehlspeisen (im Fall von Zucker) müssten dafür aus ernährungsphysiologischer Sicht verbessert werden.

Die HANCP-gestützte Überarbeitung von mehr als 200 Gerichten und Produkten in den Pilotländern Spanien und Deutschland in Zusammenarbeit mit 14 Betrieben aus der Gastronomie und Hotelbranche sowie 16 industriellen Unternehmen war größtenteils erfolgreich und resultierte in gesünderen und dennoch schmackhaften Alternativen. Die Mehrzahl der Konsumenten begrüßte das HANCP-Konzept und war mit den neuen Produkten und Gerichten zufrieden. Lediglich in einigen speziellen Fällen stießen v.a. industrielle Betriebe aufgrund von technologischen, rechtlichen und sicherheitsbedingten Problemen an die Machbarkeitsgrenzen. Begrenzte Ressourcen, sprachliche Barrieren, fehlendes Know-how sowie Zeitprobleme erschwerten die Arbeit zusätzlich. Trotz alledem konnte die Nährstoffqualität zahlreicher Gerichte und Produkte verbessert werden, auch wenn die angestrebten Ziele nicht erreicht wurden.

Das HANCP-Programm deckte das Bedürfnis der Unternehmen nach einer einfachen, rasch umsetzbaren Methode, das individuelle Ernährungsrisiko ihrer Produkte und Gerichte zu analysieren und wurde als mögliche Alternative für KMBs zu teuren Lebensmittelanalysen angesehen. Mit der Unterstützung des HANCP-Programms war es den Betrieben möglich, ihre Produkte als mögliche Kandidaten für nährstoffbezogene Angaben zu identifizieren und somit als innovatives Unternehmen von einem potentiellen Marktvorteil zu profitieren. Die Akzeptanz unter den teilnehmenden Betrieben war gut: Über 3.600 Besucher der HANCP-Anwendung weltweit (nicht nur Partnerländer) sowie über 2.000 eingegebene Rezepturen innerhalb eines Jahres bekräftigen die Bedeutung des „FOOD PRO-FIT“-Konzeptes und bestätigen die erfolgreiche Testphase des HANCP-Instruments.

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EDUCATION

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2007 – 2008: *“Gesund- und Vitalcoach“ (Health and Vital coach)*
Universitätssportinstitut Vienna
2008 – 2011: *PhD “Nutritional Sciences”*
Institute of Nutritional Sciences of the University of Vienna

WORKING EXPERIENCE

Oct. 2004 – June 2007: *Tutor of botany lab course at the University of Vienna*
Summer 2005 – 2007: *Nutritional attendant within the framework of “Dietholidays”*
Youth- and familyhostels (JFGH), 3x3 weeks, including aftercare
Aug./ Sept. 2006: *Traineeship in the range of nutritional sciences at the Dungal-
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Jan./ Feb. 2007: *Internship at the Bunka College (Nutritional college), Hiroshima*
March/ April 2007: *Traineeship “ÖSES.kid 2008” at the University of Vienna*
Sept. 2007 – June 2008: *Employee at the “Laboratory Dr. Endler”, Vienna*
Sept. 2008 – Dec. 2010: *Scientific assistant at the University of Vienna*
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ADDITIONAL QUALIFICATIONS

Foreign languages:

English, French, Latin

Foreign experience:

July 2002, Language course in Malta, 3 weeks (EF)

July 2004, Interrail, 4 weeks (F, E, P, LUX)

Jan./ Feb. 2007, Internship in Hiroshima, Japan, 4 weeks

Plenty of congresses and meetings abroad in the course of the project "FOOD PRO-FIT"
(Germany, Spain, Cyprus, France, Poland, Thailand)

Papers:

Lüftenegger S, Elmadfa I (2009): Food Reformulation – Methods, options and potential difficulties and risks. *Ernährung/Nutrition*, 33(2): 66-70

Lüftenegger S, Elmadfa I (2009): Hazard Analysis and Nutritional Control Points. HANCP, ein Instrument zur Verbesserung der Lebensmittelverarbeitung in Klein- und Mittelbetrieben. *Ernährung aktuell*, 2: 15

Oral presentations/posters:

Lüftenegger S, Elmadfa I (2008): Hazard Analysis and Nutritional Control Points. HANCP as a public health indicator for the value chain of food production processes. Annual conference of Austrian Nutrition Society 2008, Vienna, 20th/21st of November 2008

Lüftenegger S, Elmadfa I (2009): HANCP – A Self-Evaluation Tool for the Improvement of Diet Quality. Abstract/Poster for the 8th International Food Data Conference, 1-3 October 2009, Bangkok, Thailand. Book of Abstracts p.147, S5-P-1

Lüftenegger S, Elmadfa I (2009): Entwicklung eines Instrumentes auf Ebene der Lebensmittelverarbeitung zur Verbesserung der Ernährungsqualität in Europa (Projekt "FOOD PRO-FIT"). Annual conference of Austrian Nutrition Society, 10th/11th November 2009, Vienna, Austria. Abstract: *Ernährung/Nutrition*, 33(9): 377-378

Lüftenegger S, Elmadfa I (2009): Die Bedeutung von Salz, Fett und Zucker für die Gesundheit – Einstellungen von Konsumenten zu Ernährungsfragen und Lebensmittelqualität. (Poster) Annual conference of Austrian Nutrition Society, 10th/11th November 2009, Vienna, Austria.

Lüftenegger S, Elmadfa I (2010): HANCP – a strategy to adapt the food production process to consumer expectations and needs. VITAGORA – Taste.Nutrition.Health, International congress in Dijon, 23rd/24th of March, 2010; Book of Abstracts

Lüftenegger S (2010): Reformulation of Food Production Concepts as Strategy to Improve the Diet Quality in Europe. Nutritional Colloquium Summer 2010 by the Institute of Nutritional Sciences of the University of Vienna, 17th of June 2010

Lüftenegger S, Elmadfa I (2010): Reformulating food production concepts to improve the diet quality in Europe. Poster, World Congress of Public Health Nutrition, Porto, 23rd-25th of Sept 2010; Book of Abstracts

Lüftenegger S, Elmadfa I (2010): Including "Nutritional Control Points" into the Value Chain of Food Production, Transformation and Service Processes. Oral presentation + Poster, Joint COST – Eureka Science Event, Graz/Austria, 6th of October 2010