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Framework for product reformulation: The integration of four disciplines; Nutrition & health, Food technology, Legislation and Consumer perspective

Obesity and other lifestyle-related diseases are, amongst others, the result of an unbalanced diet and lifestyle. Excessive intake of energy, salt, saturated fat and sugar are leading to increased risk of chronic diseases, such as cardiovascular diseases, cancer and diabetes (WHO/FAO). Therefore, a healthier food intake (diet) is needed. But when is a food product healthier? From a nutritional perspective it is clear: the lower the levels of nutrients with a negative public health impact, the better the product fits in a healthy diet. However, when it comes to improving the health impact of the food supply through reformulation, other aspects are important as well. This article describes the 'framework for product reformulation', which integrates four essential disciplines: Nutrition & health, Food technology, Legislation and Consumer perspective.

Reformulation has been the subject of many studies. However, to our knowledge no articles focussing on the integration of all four disciplines have been published. Food Technology and the Consumer perspective were integrated to develop a concept of consumer-driven food product development[1]. Grasso *et al.* discussed not only the technological aspects, but also legislation and the consumer perceptions of reformulated meat products[2]. Buttriss described the public health challenges of the diet and the technological aspects of reformulation[3]. The authors concluded that a multidisciplinary approach is needed. The aim of this paper is to describe and illustrate the 'Framework for product reformulation' as an integrated model for reformulation processes. This framework involves four essential disciplines: Nutrition & health, Food technology, Legislation and Consumer perspective (**Figure 1**, page 29). Our focus is on meat and bakery products in Europe (The Netherlands, United Kingdom

In meat and bakery products salt affects texture as well as taste

and Denmark), because these product groups are important contributors to the intake of energy, salt, saturated fat and sugar.

Nutrition & health

Decreasing the intake of energy, salt, saturated fat (SFA) and sugar has been the focus of many initiatives from government, industry and non-governmental organisations worldwide. In 2004 the WHO Global Strategy on Diet, Physical Activity and Health provided an action plan on the reduction of nutrients with negative health impact[4]. National governments harmonised policy goals towards standards for food categories with the ultimate aim of helping consumers make healthier choices. Reduction of salt and trans fatty acids were the first aims, followed by saturated fat and sugar. Table 1 summarises the intake of salt, saturated fat and sugar in the three selected EU countries. The dietary intake goals (Table 1) have been translated into criteria for products or product categories. Bread, cereals and bakery products are the main source of salt intake, followed by meat products, cheese and dairy products[5]. Table sugar, dairy products, soft drinks and sweet and bakery products are the main source of sugar intake[6]. The SFA intake is dominated by cheese, especially in the Netherlands, and by meat products and sweet and bakery products[7]. A positive example for reformulation is the UK, where salt intake was reduced from 9.5g/d in 2000/2001 to 8.1g/d in 2011[8], concluding that the product categories of bakery and meat products are important targets for reformulation.

Food technology

Salt, saturated fat and sugar have specific technological functions in food products which determine the possibilities of reformulation. Generally there is no single ingredient that can replace all the technical functionalities, therefore multiple reformation strategies are required.

Salt primarily affects the salty taste and aroma profile of products. In meat and bakery products salt also affects the texture and is important for processing. It acts as a preservative and can control fermentation processes. Different strategies were developed to compensate for the reduction of taste in salt or sodium reduced food products[15]:

- Use of sodium replacers (KCl and MgSO4,). Next to the salty taste these minerals also contribute to the texture and microbial stability of the product. Owing to a negative impact on the taste profile some of these salts can only be applied at a limited concentration, otherwise masking agents need to be added
- Use of salt enhancers and salt boosters. Examples are monosodium glutamate (MSG), lactates, yeast products and flavours
- Optimisation of the physical distribution of the salt in the product. An inhomogeneous distribution of salt results in a frequent stimulation of taste receptors resulting in taste enhancement
- Use of cognitive mechanisms, such as the consumer awareness of sodium reduction, a step-by-step reduction, which has been applied to reduce salt in bread.

The technological functionality of fat differs over the various product categories. Reformulation of fat can focus on lowering the total amount of fat and/or lowering the amount of saturated fat by changing of the fatty acid composition. Fat determines the hardness, spreadability and

Table 1: Salt, saturated fat (SFA) and sugar intake in The Netherlands, Denmark and UK and recommended intake goals[9-11]

Intake	Netherlands	Denmark	UK	Recommended intake goals by WHO[12,13]
Salt (g/day)	8.7	8.6	8.1	<5
SFA (En%**)	13.8 En% (29-38g/day)	14.5En% (30-42g/day)	12.8En% (27-37g/day)	<10
Added/ Free Sugar*** (En%)[2]	9-12 En% (42-74g/day)	9 En% (48g/day)	11.5 En% (58.8g/day)	Free sugar: <10 Conditional recommendation <5

**%En =recommended maximum amount of energy delivered by this nutrient (kcal), divided by the recommended total daily energy (2000 kcal for women) multiplied by 100.

2***Free sugar or added sugar: all mono- and disaccharides from other sources than fruits, vegetable and dairy; It is assumed that 2/3 of the total sugar intake comes from added sugars or free sugar[14]

texture of products. Moreover, fat stabilises foam structures, acts as a barrier between different layers and delivers translucency and gloss. Furthermore, fat has an enormous impact on flavour.

Two basic approaches to manufacture low-fat products are the use of leaner raw materials and/or the reduction of fat by adding water and/or other ingredients that have less or no calories, such as fibres or fat replacers. Fat replacers have the functionality of fat, but less calories (polysaccharides, proteins, fibres). Fat substitutes resemble fat, but are not digested in the human body and are reduced in calories. Saturated fat reduction can change the fatty acid composition without affecting the total fat content, by substituting fat (rich in saturated fatty acids) with vegetable oils which are rich in unsaturated fatty acids. The loss of structure from substituting solid fat with liquid oil needs to be compensated.

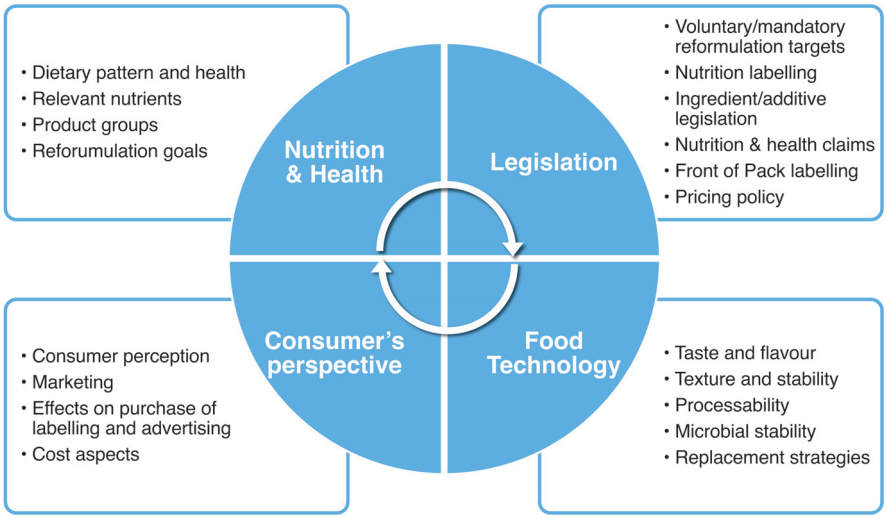

Figure 1: The four disciplines of a Reformulation process and main topics per discipline. Disciplines: Nutrition & Health, Food Technology, Legislation and Consumer's perspective

Reducing the amount of added sugars can be an effective way of reducing energy density in sweet bakery products. In general, the functions of sugars are: sweetness, texture, bulking, source of colour and flavour and preservation. The sweetness can be maintained by the addition of high intensity sweeteners. Texture and mouth feel of moist products can be compensated by the addition of hydrocolloids. The bulking or volume of sugars, mainly in low moist products, can be taken over by such bulking agents as polyols and fibres.

> "Reducing the amount of added sugars can be an effective way of reducing energy density in sweet bakery products"

Legislation

For decades the two main drivers for reformulation have been debated: legislation by governments or voluntary covenants with the food industry. Many initiatives for salt reduction have been started – and these have mostly been national approaches. Recently, a European approach on food improvement has been agreed[16]. In the past the UK programme for salt reduction, a voluntary partnership with the government, private sector and NGO partners, was very successful. Strong government leadership and pressure, reinforced by robust monitoring mechanisms underpinned by active NGOs, were important drivers for this success. A salt reduction of 14-15% in bread in the Netherlands was reached as a result of a voluntary covenant between the Dutch government and the bakery industry. In response to a request from the bakery sector, the Dutch government changed the national bread legislation by lowering the maximum allowed salt level in two steps from 2.5 % to 1.8 % of dry matter[9]. Taxation of sugar is currently discussed in the UK[17] , however Denmark's previous taxation of saturated fat in foods had marginal effects during it short existence[18].

The Dutch government changed the national bread legislation

In Europe most of the food legislation is EU legislation. The regulation for the provision of food information to consumers is obligatory for nearly all food products[19]. The label has to contain the ingredient declaration and Nutrition Table (per 100 gram). This table on pre-packed foods is a prominent source of nutritional information on the back of the pack, to help consumers make healthier choices. The use of nutrition and health claims in the EU is voluntary, but regulated[20], nutrition claims are more frequently used. A 'nutrition claim' means any claim which states, suggests or implies that a food has particular beneficial nutritional properties (Table 2, page 30).

Also the use of Front-of-pack (FOP) labelling, such as health logos, traffic light systems and/or Reference Intakes, is also voluntary. All are introduced to guide the consumer to a more healthy choice. Products must comply with the criteria for ingredients such as salt, trans fat, saturated fat, (added) sugar and energy.

Figure 2: Examples of Front of Pack labelling used in The Netherlands, Denmark (health logo) and in the UK (Reference intakes with traffic light colouring)

Consumer perspective

In general, three factors affect consumer decisions in relation to food intake: social psychological, economic, and environmental. Generally, the sensory properties (taste, smell and texture,) of foods have the most powerful influence on consumers[21]. Consumers accustomed to high concentrations of salt/sugar in food have difficulty accepting reduced salt or sugar products. A change in consumer behaviour is required to ensure that lower salt/sugar products will be accepted and to prevent consumers adding salt during cooking. The step-by-step reduction in salt/sugar is only possible with the consensus of all manufactures in a product group. Marketing is crucial, as consumers may assume that reformulated products won't taste as good, because they associate low fat/sugar with less taste. Consumers may accept reformulated products better if they either do not know that they are reformulated, or if they are marketed as a 'healthier' product[22].

> "Price aspects of food products are a very important driver for both retail and consumers"

Table 2: Possible nutrition claims for reduction of (saturated) fat, sugar and salt, including their conditions for use[20]

Claims	Condition: maximum level
Low fat	3g/100g, 1.5g/100ml
Fat-free/Without fat	0.15g per 100g/100ml
Low saturates/ saturated fatty acids	1.5g/100g for solids, 0.754g/100ml for liquids
Saturates/saturated fatty acids free Without saturates/ saturated fatty acids	0.1g per 100g/100ml
Low sugar(s)	No sugar (codex) Some members : maximum. 4g/100ml for soft drinks or maximum 5g per 100g/100ml.
Sugar(s)-free/ without sugar(s)	0.2g per 100g/100ml (codex) Some members: 'The product contains no sugars, similar products may contain sugars' or 'The product does not contain any kind of sugar'.
Low sodium/ salt	Low sodium: maximum 0.12g/100g Very low sodium: maximum 0.04g/100g Some members: Low sodium: maximum 0.04 sodium per 100g/100ml.
Sodium/ salt-free Without sodium/salt	0.005g/100g

Consumers report to look at the nutritional information, but studies in 27 European countries showed that consumers make very fast choices at the shelf, using information selectively[23]. Although consumers evaluate the Nutrition Table positively, it receives little attention and does not stimulate healthy choices. While consumers in the EU have a reasonable knowledge of nutrition and most consumers can use FOP labels (Figure 2) when prompted, only a minority actually reads this information when shopping[24]. Whether these FOP labels affect consumers' purchase decisions is still under discussion. Studies describe the effect in the range of 'unknown' to 'they seem to enhance healthy product choice', even when consumers were put under time pressure[24,25]. Consumers prefer short simple claims over long, complex and scientific claims and have a preference for claims with supporting information on the back of the package.

Price aspects of food products are a very important driver for both retail and consumers. Reformulated products are generally more expensive than their traditional full-fat, sugar or salt counterparts. The cost of reformulation includes the cost of new ingredients, changes of food processing machinery, staff time and training, as well as the cost of changing labels[22]. However, most retailers and consumers require that reformulated products have the same taste and no higher price as their original counterparts. A reverse approach is to demotivate the choice for

Meat and bakery are important contributors to the intake of energy, salt, saturated fat and sugar

products high in salt, fat and sugar by, for example, taxation of sugar or fat, restrictions in advertising, and limiting selling points. This was discussed above. It is probable that a combination of several measures will be needed to stir the consumer to reformulated products[26].

Conclusion and outlook

In summary, this article presents an integrated approach towards reformulation of foods with respect to salt, sugar and (saturated) fat content. Reformulation has been discussed from four disciplines: Nutrition & health, Food technology, Legislation and Consumer perspective. The integrated approach is essential for the successful development of 'healthier' products.

Nutrition & health is and will always be the driver for reformulation. Governments have aimed to reduce our intake of salt, sugar, trans fat and saturated fat over the last decade and will continue to do so, whilst ensuring consumers are not being misled. Until now salt and trans fat have been the main focus. The solutions available to food producers can be limited by legally approved ingredients and by the food technological solutions that are available. In many scientific publications on reformulation the focus is solely on the technological possibilities in relation to sensory perception. This should be integrated with consumer acceptance of the applied ingredients and technologies, the impact of these ingredients and technologies on labelling, price and industrial production. In our view, food producers can only successfully reformulate their products and maintain their competitive advantage if the four disciplines discussed here are an integral part of their product development. In particular, the expected further limitation in the levels of salt, sugar and (saturated) fat in various categories of foods will force food producers to approach this challenge with the integrated approach that is proposed by the Framework reformulation.

About the Authors

Fred van de Velde is Principal Scientist of Texture Perception at NIZO food research and Senior Researcher/Lecturer at HAS University of Applied Sciences. He has a PhD in biocatalysis from the Technical University of Delft and 16 years' experience in food ingredients and proteins, including both dairy and plant proteins. Fred's areas of expertise are the relationship between the molecular structure of food ingredients, their interactions, microstructure and texture on the one hand and product stability and sensory perception on the other hand. To date, he has published more than 65 research articles and he is (co)-inventor of over 10 patent applications.

Annelies van Gunst is a Lecturer/Advisor at HAS University of Applied Sciences and has been a member of the Department of Food Technology since 1991. She has a Master degree in Biology. During her career at HAS University she gave lectures and did research on several subjects including: Food microbiology, Product development, Food legislation and Qualitative research in the food sector. At this moment Reformulation of salt, saturated fat and sugar in the Meat and Bakery sector is her main study subject.

After her PhD in nutrition at Wageningen University, **Annet Roodenburg** worked as a nutrition scientist at Unilever Research, in various management and research roles. Since 2010 she is Associate Professor of Nutrition & Health at the HAS University of Applied Sciences, in Den Bosch, The Netherlands. Her main topics are: nutrient profiling (When is a food healthy?), on pack health communication, reformulation, nutrition for target populations (elderly), with focus on the role of the food industry.

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