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The "Menu Sustainability Index"

Assessment of the environmental and health impact of foods offered in commercial catering

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Summary

Diet-related diseases are becoming increasingly common and the food that is consumed places a considerable burden on the environment. In view of the need to assure a sustainable development in society, it is important to support and promote the consumption of healthy and environmentally friendly foods. The "Menu Sustainability Index" (MSI) is a scientifically based and user friendly tool that has been developed for use in Swiss commercial catering establishments to evaluate and optimise the available foods from both a health and environmental perspective. As in the approach of food reformulation, this is intended to create an environment for consumers facilitating balanced and environmentally friendly nutrition. The MSI also enables kitchen managers and catering staff to enhance their knowledge of healthy and environmentally friendly dietary choices. The MSI tool is currently available as a prototype, which is being further developed as part of a research project.

Keywords: Menu Sustainability Index, environment, health, commercial catering, communal catering, sustainability, sustainable nutrition

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Introduction

Our eating habits have a direct influence on our health and, furthermore, our choice of food has a considerable impact on the environment. It has been estimated that 28% of the environmental burden in Switzerland is related to food consumption [1]. It is therefore important and meaningful to support a balanced and environmentally friendly nutrition both to promote health and protect the environment.

If this is to be achieved, an appropriate range of foods and meals must be available and these must be properly evaluated and labelled. Since out-of-house consumption is increasingly gaining in importance, raising awareness of sustainable nutrition in this catering sector can reach a broad segment of the population and hence is particularly relevant. Apart from the health and ecological aspects of sustainable nutrition that have already been addressed, there are also social, economic and cultural aspects that need to be considered [2].

At the moment, there are few available guides in Swiss commercial catering establishments to help consumers to select sustainable nutrition. Although some large caterers offer a range of meals in accordance with current nutritional recommendations or environmentally friendly dishes [3], there is no comprehensive evaluation or labelling of the dishes. Moreover, most catering facility managers do not possess the necessary knowledge or suitable tools to compile a range of sustainable dishes or to optimise their current selection. This paper presents such a tool, the so-called "Menu Sustainability Index" (MSI), which is currently under development at the Zurich University of Applied Sciences.

Existing instruments and methods on the "sustainable assessment" of foods

There are currently several tools available to evaluate the environmental (ecological effects of food cultivation and processing) and/or health effects (nutritional balance) of dishes in commercial catering. However, other aspects of sustainability, such as social aspects (social solidarity) and cost-effectiveness (economic criteria) have hardly been examined, if at all. ◆ Table 1 lists a selection of the available tools.

Instrument	Dimension(s) considered	Indicators	Developer [Reference]
Bewusst Genießen ("Conscious Enjoyment")	health	energy, fat (amount & quality), protein, starch (weight & type of starch component), amount of fruit & vegetables	*ZFV-Unternehmungen* ("ZFV Companies") [4]
Healthy Meal Index	health	weight of fruit & vegetables, fat content and quality, amount of whole grain products & potatoes	Department of Nutrition, National Food Institute, Technical University of Denmark [5]
WHO/European Pledge	health*	standard values for total fat, saturated fatty acids, sugar, salt, total energy	WHO Europe [6]
Eaternity App	environment	CO_2 footprint	Eaternity [7]
BEELONG	environment	origin (distance & type of transport), seasonality, production method, degree of processing, climate & resources (CO_2, land use, water shortage/ pollution)	*Ecole hôtelière de Lausanne [8]*
Nutritional Footprint	health & environment	energy, salt and nutritional fibre content, quantity of saturated fat, material, CO_2, water footprint, land use	Wuppertal Institute for Climate, Environment and Energy GmbH [9]
SusDISH	health, environment (& economy)	12 reference values of the German Nutrition Society (DGE) in communal catering & content of essential protein, salt, cholesterol & vitamin B_{12} ecological scarcity method (UBP)	Martin Luther University Halle-Wittenberg [10]
Menu Sustainability Index (MSI)	health & environment	15 or 8 nutrients [precise description: section "Menu Sustainability Index (MSI)"], ecological scarcity method (UBP)	Zurich University of Applied Sciences (ZHAW) [11]

Tab. 1: **Selection of existing tools to evaluate meals in commercial catering with respect to health and the environment**
*Purpose: specifically for children's meals for marketing constraints
UBP = eco points (EP); WHO = World Health Organisation

To assess the environmental impacts associated with meeting the need for nutrition there are many methods available, but these methods have often been designed to address a variety of problems with different research objectives [12, 13]. The European Commission indicates that the Life Cycle Assessment Method is the most appropriate approach to evaluate the environmental effects of products [14]. In a Life Cycle Assessment, the consumption of resources and the generation of emissions are systematically quantified (life cycle inventory modelling) and the potential environmental consequences are then modelled (impact assessment) [15]. Impact assessment methods that have already been used in gastronomy to evaluate the ecological sustainability of meals include CO_2[1], ecological[2], water[3] and material footprints[4]. Further methods include the land use method[5] and the ecological scarcity method (◆Table 1). The ecological scarcity method is a fully aggregating method. Of the methods listed, this provides the most comprehensive impact assessment since it considers numerous resources (e.g. use of energy, land and water resources), pollution categories (e.g. greenhouse gases, carcinogenic pollutants, heavy metals, herbicides, radioactive emissions) and categories of waste. The evaluation of the environmental impacts of products is then based on ecological factors, which reflect both the current emission situation and the political emission goals within Switzerland [21]. The result is expressed in so-called eco-points (EP = UBP).
There are also various approaches to evaluate the "health value" of foods and meals. One of these is the so-called nutrient profiling. According to the World Health Organisation (WHO) [22], this is a scientific method to evaluate the nutritional quality of foods and beverages. The principle of nutrient profiling is based on the assumption that some foods make a greater contribution to healthy nutrition than others. Nutrient profiles are seen as effective tools to interpret the complex nutritional understanding of a whole diet to the level of individual foods [23]. The demands made on these profiles, however, are very diverse and have triggered a great deal of political and scientific debate [24]. For this reason, there are numerous nutrient profiles that are compiled in different ways. In the context of the MSI, future validation will establish if the principle of nutrient profiling can be transferred to complete menus and hence to

[1] Cumulative greenhouse gas emissions over the life cycle of a product, expressed in kg CO_2 equivalents [16].
[2] Area needed for the resources to produce the product (including area to absorb CO_2 emissions) [17].
[3] Fresh water volume needed for the production of a food, including the supply chain [18].
[4] Total mass of all biotic and abiotic (raw) materials needed for the preparation of foods [19].
[5] Total area needed for the preparation of foods [20].

assessment of the menu's health value (see the next section).

The Menu Sustainability Index (MSI)

The Zurich University of Applied Sciences (ZHAW) has developed the Menu Sustainability Index (MSI). This is a tool for the assessment and optimisation of meals in commercial catering with respect to the sustainability dimensions environment and health (from a nutritional standpoint). Social and economic aspects have not yet been considered but will be integrated during subsequent development. Based on the approach of food reformulation [25, 26], this is intended to provide a tool for kitchen managers that permits a "reformulation" of menus and simplify it for consumers to select healthy and environmentally friendly meals in commercial catering. It was developed as part of various university student projects and is currently available as a prototype [27–29]. The MSI does not take beverages into account.

The MSI differs from the two models (Nutritional Footprint und SusDISH) that also incorporate health and environmental aspects (◆ Table 1) in the following respect: Whereas the Nutritional Footprint model from the Wuppertal Institute combines the two dimensions of environment and health in a single index (value), the MSI evaluates and presents these two aspects separately. In this way, it is possible to distinguish between dishes that are environmentally friendly but nutritionally unbalanced and those that are environmentally unfriendly but nutritionally balanced. This permits consumers to reach a decision based on personal preference. It is also easier for catering staff to use this tool as it considers the two dimensions separately. Furthermore, the MSI employs the more comprehensive ecological scarcity method to evaluate environmental stress and the evaluation of the nutritional quality also includes more nutrients than in the Nutritional Footprint leading to greater differentiation in the results. The SusDISH concept was developed as an advisory tool and is a service offered to catering units to optimise the dishes they provide with respect to the environment, health and cost-effectiveness. In contrast the MSI and corresponding tool are intended to be freely available to Swiss commercial caterers. The intention is that kitchen managers should independently be able to determine the MSI for their dishes and then implement improvements. This will enhance the knowledge of the kitchen staff and thus guarantee long-term improvements in the sustainability of the meals provided. Although the method developed is scientifically based, the focus of the MSI tool is on user-friendliness.

Evaluation of the nutritional balance of dishes in the MSI

Two models with different approaches were developed at the ZHAW to evaluate the nutritional balance of dishes. Whereas the basis for calculation in the model of Nutritional Stress Points (NSP) is the ecological scarcity method the Nutritional Balance Points model (NBP) is based on the nutrient profiling model of the Food Standard Agency (FSA) [30]. The two models (as prototypes) are compared in ◆ Table 2.

In deviation from the D-A-CH reference values, the Swiss Nutritional Commission gives the recommended percentage of total fat in energy supply to adults as 20–40% [36]. The NBP model, therefore, gives the maximal acceptable level of total fat according to the reference value of 40%. The recommended portion of added sugars, 10% of energy content (En%) [38], transferred to a midday meal (18g sugar) was considered to be too high. The reason for this assumption is that sugar is mainly consumed at breakfast and in snacks between meals. In the NBP model, it is assumed that a midday meal without dessert does not contain any major sources of sugar, apart from the naturally-occurring sugar contained in the vegetable side dish (mean 8 g/menu). The nutrition facts used to calculate NSP/NBP values have been taken from the German Food Database (*Bundeslebensmittelschlüssel*, BLS 3.02).

Both models have advantages and disadvantages. With the NSP model, different nutrients can be directly adjusted with specified weighting factors, whereas only indirect weighting is possible in the NBP model. The latter is based on the different numbers of points awarded for qualifying or disqualifying nutrients. However, weighting in the NSP model is only possible if consumption data is known, and this is only due to be published in Switzerland at the end of 2016 [39]. For this reason, the weighting factor in the current NSP model is 1.0 for all nutrients. One important advantage of the NBP model is that the determined score, which always varies from -40 to 20, allows dishes to be assessed independently of the provider or a defined "core menu" (which is the case in the current NSP model). Both approaches are innovative and new, but are based on know-how from established methods.

Evaluation of the ecological burden of dishes in the MSI

To assess the ecological sustainability of dishes, the Life Cycle Assessment Method was used for the MSI, in combination with the method of ecological scarcity established in Switzerland expressed as eco points (UBP) (see [21] for a de-

	NSP Nutritional Stress Points	NBP Nutritional Balance Points
Selection criteria for nutrients	a) Scientifically proven correlation between the supply of the nutrient and the risk of nutritional diseases b) Nutrient is needed to maintain physical functions c) Supply of nutrients in the Swiss population is not in accordance with the recommendations	a) Scientifically proven correlation between the supply of the nutrient and the risk of nutritional diseases b) The goals of the Sixth Swiss Nutritional Report (SEB) have been achieved by increasing or decreasing the supply of the nutrient (overweight reduced, sugar supply reduced, supply of fruit and vegetables increased) [31] c) Supply of nutrients in the Swiss population is not in accordance with the recommendations
Integrated nutrients	Energy, fat (SFA, MUFA, PUFA), carbohydrates, proteins, dietary fibre, sodium, calcium, magnesium, iron, folic acid, vitamin B_{12}, weight of fruit/vegetables	*Qualifying Nutrients*: UFA, dietary fibre, proteins, fruit/vegetables weight *Disqualifying Nutrients*: energy, fat, sugar, salt
Reference values*	energy ≤ 717 kcal carbohydrates ≥ 50 En% proteins ≤ 20 En% fat ≤ 30 En% SFA ≤ 10 En% MUFA 10–15 En% PUFA 7–10 En% dietary fibres ≥ 10 g sodium ≤ 984 mg calcium ≥ 333 mg magnesium ≥ 117 mg iron ≥ 5 mg folic acid ≥ 133 µg vitamin B_{12} ≥ 1 µg fruit/vegetables weight > 120 g For all the listed reference values, a deviation of +/- 10% is tolerated in the model (= recommended interval).	energy 700 kcal proteins 15–20 En% fat 40 En% UFA 75 % of total fat dietary fibres 10 g salt 4 g free sugar (intrinsic) 8 g fruit/vegetables weight 120 g
References for reference values	[32–35]	[32, 33, 36, 37]
Basis for calculations	The evaluation of the individual nutrients is based on a two-step calculation model: 1. Stress (n_i): percentage deviation of the menu nutritional value from the reference value → the greater the deviation, the higher the stress number 2. Weighting (W_i): Deviation of the actual consumption in the Swiss population from the corresponding nutritional recommendations → the greater the deviation, the greater the weighting factor $\text{NSP 1.0} = \frac{\sum_{i=1}^{m} n_i \cdot W_i}{\sum_{i=1}^{m} W_i}$ $n_i = \left\lvert \frac{N_i - K_i}{K_i} \right\rvert$ if N_i is not within the recommended interval, otherwise 0 m: number of nutrients N_i: energy/nutrient value of a menu K_i: critical reference value +/- 10% tolerance	The individual nutrients are evaluated with a point system (based on the FSA model [30]). The maximal point number for qualifying nutrients is 5 and for disqualifying nutrients 10. A point number of 5 always means that the recommendations for a midday meal (with a portion of 520 g) are reached for the individual nutrient. $\text{NBP 2.0} = \sum \textit{Points qualifying nutrients} - \sum \textit{Points disqualifying nutrients}$
Results	Values of ≥ 0 The higher the value, the more “stressful” is the menu (greater deviations from the recommendations).	Values from -40 to +20 The greater the score, the more balanced is the menu.

	NSP Nutritional Stress Points		NBP Nutritional Balance Points	
Interpretation of results	For an optimally composed dish, in accordance with the recommendations, the NSP value is 0. The upper limit is determined with a selected "core menu". The interval between the lower limit (NSP = 0) and the specified upper limit (NSP = 0.3293) is split by a p-quantile determination into 6 sections with corresponding colour category [from dark red ("stressful", unbalanced) to dark green ("non-stressful", balanced)]:		If all nutrients are within the recommendations, the score is ≥ 0. Split into four ranges:	
	dark green:	≤ 0.0823	balanced:	≥ 0 to 20
	light green:	0.0824–0.1234	rather balanced:	< 0 to –4
	yellow:	0.1235–0.1645	rather unbalanced:	< –4 to –8
	orange:	0,1656–0,2057	unbalanced:	< –8 to –40
	red:	0,2058–0,246		
	dark red:	≥ 0,247		
	≥ $q_{0.750}$ ≤ $q_{0.750}$ ≤ $q_{0.625}$ ≤ $q_{0.500}$ ≤ $q_{0.375}$ ≤ $q_{0.250}$			
	NSP = 0,3293	NSP = 0		

Tab. 2: **Comparison of the two models developed to evaluate the nutritional balance of dishes**
* Reference values are with reference to the recommendation for a midday meal (by thirds, as used by the German Nutritional Society [DGE]). Target group: adults of normal weight aged between 19 and 65 years, with a PAL of 1.4
** The "core menu" was selected from more than 800 dishes from a large Swiss caterer, in such a way that the nutrient composition of the menu corresponds as little as possible with the reference values. An NSP value of 0.3293 was calculated for this menu.
En% = energy percent; MUFA = mono-unsaturated fatty acids; NBP = Nutritional Balance Points; NSP = Nutritional Stress Points; PAL = physical activity level; PUFA = polyunsaturated fatty acids; q = quantile; SFA = saturated fatty acids; UFA = unsaturated fatty acids

tailed description of the method). The principle reasons for the selection of the method of ecological scarcity were that it covers a broad spectrum of environmental impacts, that the weighting of the individual environmental impacts is based on Swiss environmental objectives [21] and that data is available for many different foods. Even though this method is sometimes criticised for giving an evaluation that is politically dependent [40], experts regard it as a suitable approach, particularly for addressing nutritional issues in Switzerland [41].
The UBP data used, together with the corresponding metadata, were compiled by the company ESU-services Ltd. in Zurich in 2011 [42]. Some common components of recipes – such as salt, rice and drinking water – cannot be assigned any UBP values from the data from ESU-services Ltd. For these foods, UBP data were taken from the ecoinvent v2.2 database [43]. If there were no UBP values of any sort for a product, mean values were taken for similar products (e.g. the UBP value for vegetables in general was taken for zucchini). In future developments of the MSI, existing data will be replaced by up-dated values as available, although this is not expected to result in any considerable differences.
The UBP values determined do not as yet provide any information about the "strength" of the environmental stress of a menu. For this purpose, minimal or maximal values must be defined so that an index is generated. As already mentioned in the NSP model (◆ Table 2), this has been performed on the basis of specified "core menus" (selected from more than 800 recipes of a large Swiss caterer); the very low or very high UBP values are used to define the upper and lower limits of the index. The range between these extremes is divided into six sections using a p-quantile calculation, marked in the colours dark red (high environmental stress) to dark green (low environmental stress) (◆ Figure 1).

Application of MSI

The Institute of Applied Simulation of the ZHAW has developed a program based on Access (the MSI tool) for the automatic calculation

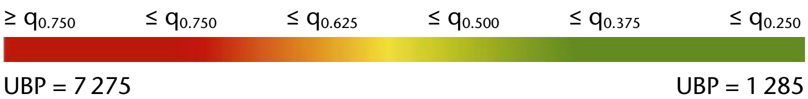

Fig. 1: **Division of the defined UBP intervals into 6 sections with the p-quantile classification**
≥ 5 781: dark red section; 5 029–5 780: red section;
4 280–5 028: orange section; 3 531–4 279: yellow section;
2 783–3 530: light green section; ≤ 2 782: dark green section
q = quantile; UBP = eco points

or allocation of NSP/NBP and UBP values, as well as index calculation and the graphical presentation of the results. Recipes can be entered into this tool and menu descriptions can be printed out directly, including the specific MSI and an information sheet. The interface of the database is based on the existing order and recipe databases of large caterers. It is also possible to integrate the database into the programs of commercial caterers. This means that there is little additional work for the user of the MSI. ◆ Figure 2 shows three print-outs of the MSI. The "health evaluation" of the spring rolls is inferior to that of the breaded pork cutlet or the vegetable lasagne due to the high fat and low carbohydrate content (percentage relative to the dishes' energy content). Yet because of the lack of meat, the spring rolls and vegetable lasagne lie in the green (favourable) section for eco points, while the meat dish is in the yellow section.

Conclusion and outlook

There are many possible ways of quantifying environmental stress as well as the nutritional quality of dishes. The MSI introduced in this article is a tool that links both aspects. Moreover, it is based on scientific principles and is also user friendly. Because of the structure of the MSI tool – based on the order and recipe databases of large caterers – the MSI can be determined with little additional effort and can aid kitchen managers in compiling environmentally friendly and healthy menus. The MSI can increase the knowledge of the kitchen staff and, in the long term, serve to optimise the food available to consumers. The objective should be to offer as many dishes with good ratings for both health and environment as possible (see the example "vegetable lasagne with salad side-dish"; ◆ Figure 2) which consumers enjoy eating.

The MSI is the first instrument in Switzerland that integrates both detailed environmental and health aspects of nutrition and which can be used to evaluate and distinguish dishes in commercial catering.
In the course of a research project – supported by the Mercator Switzerland Foundation – both models to evaluate nutritional balance (NSP and NBP) are further developed and validated with the help of external experts. The focus is also on the integration of current UBP values and the scientifically based derivation of standard values to classify eco points as high or low. Initial studies have already been performed and there are various approaches that must be validated. In addition, the research project is evaluating various methods to present the MSI results with diverse modes of communication. A field trial at 2–3 establishments within a large Swiss catering firm to check the efficacy of these measures is planned for 2017.
After the project has been completed, the MSI will be available to all commercial caterers. Each user will have to pay the licence fees for the UBP values stored in the MSI and the nutrient databases.
The next step is for the MSI to be further developed into a comprehensive sustainability assessment tool by the inclusion of the sustainability dimension "social".

Fig. 2: **MSI print-outs, as generated by the Access tool**
Examples: breaded pork cutlet, vegetarian spring roll and vegetable lasagne; evaluation of the nutritional balance on the basis of the NSP model
NSP = nutritional stress points; MSI = Menu Sustainability Index

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Conflict of Interest
The authors declare no conflict of interest.

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