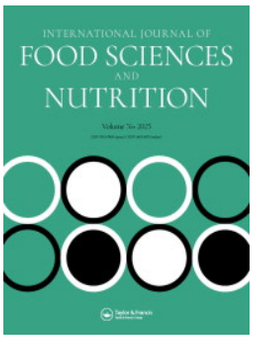

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Nutrient quality of beverages: comparing the Nordic Keyhole, Nutri-Score and Nutrient Rich Food indices

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ABSTRACT

The nutrient quality of 96 beverages in Sweden was assessed based on the Keyhole (KH), Nutri-Score (NS) and Nutrient Rich Food (NRF) index. Of milk- and plant-based beverages, 20% were similarly rated by all three as either high or low quality. Keyhole evaluated plain milk more coherently to the dietary guidelines, whilst NS assessed plant-based beverages more consistently than other indicators. Of water-based beverages, 61% were similarly rated by NS and NRF, with highest alignment in sugar-sweetened and non-nutritive sweeteners containing beverages. According to NS, water, unsweetened beverages, freshly squeezed fruit juices and vegetable juices qualified as nutritious choices. NRF index evaluated beverages less coherently to the guidelines and the rating of products largely mirrored fortification. Thus, agreement among indicators varies across beverage groups. NS is suitable to rate the nutrient quality of most beverages consistently with the dietary guidelines, except for milk where KH outperforms NS.

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Nutrient indicator; front-of-package label; beverage; Nutri-Score; Keyhole

Introduction

It is universally agreed that efforts to transition the food system towards higher sustainability need to accelerate globally (UN 2015; FAO and WHO 2019; IPCC 2023). The European Union (EU) Farm-to-Fork Strategy seeks to address the challenge of securing a sustainable food system and in this effort emphasises the role of information through front-of-package nutrition label (FOPNL) to empower consumers to make informed, healthy and sustainable food choices (European Commission 2020). The European Commission (EC) is working towards a harmonised mandatory FOPNL and an integrated sustainable labelling framework. Although there is currently uncertainty about which common nutrition labelling scheme will be adopted, several scores and symbols are currently used on a voluntary basis in Europe (Narciso and Fonte 2021). Among these, the Keyhole (KH) is predominantly used in northern EU and the Nutri-Score (NS) in western EU (Peonides et al. 2022).

The KH was introduced in Sweden over 30 years ago and subsequently expanded to Denmark, Norway, Iceland, Lithuania and North Macedonia (van der Bend and Lissner 2019). The KH is a directive, binary labelling system (yes or no), which aims to help consumers identify healthier choices within a food group (Swedish Food Agency; SFA 2022).

NS is a numeric indicator that rates foods on a five-grade scale (A–E, from highest to lowest nutrient quality) based on the content of certain nutrients and food components (e.g. fruit, vegetables and legumes) (Julià and Hercberg 2017). As the voluntary adoption of NS has expanded to several EU countries, more research is being conducted on its impact on consumers' choices. Some studies suggest that NS slightly outperforms other labelling schemes in guiding consumers towards healthier foods (Egnell et al. 2020; Hagmann and Siegrist 2020; Pettigrew et al. 2023), whilst others report more inconclusive results (Braesco and Drewnowski 2023). New studies are also arising where NS is assessed alongside environmental impacts to provide a more holistic sustainability evaluation of foods (Clark et al. 2022; Potter et al. 2023).

In the scenario of an integrated sustainable labelling EU framework, other nutrient quality indicators might become relevant. Like NS, the Nutrient Rich

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Food (NRF) index is a summary indicator, with a long history of application in nutritional assessments of foods and diets (Fulgoni et al. 2009; Drewnowski 2010). Although no direct use of NRF as FOPNL is reported within the EU, this indicator is of interest for its suitability to be incorporated in environmental assessments of foods and as functional unit in life cycle assessment (LCA) (McLaren 2021). A variant of the NRF index has been tailored to better cover the nutritional needs of the Nordic population, by including additional nutrients as compared to the base indicator NRF9.3 originally developed and validated in the US. The NRF11.3 index is suitable to assess the nutrient quality of foods with high coherence to the Swedish food-based dietary guidelines (Bianchi et al. 2020; Strid, Hallström, et al. 2021) and further validated as predictor of diet quality in a cohort study in Northern Sweden (Strid, Johansson, et al. 2021).

A high degree of coherence with dietary guidelines is an important pre-requisite for nutrient quality indicators and a required step in the validation process (Cooper et al. 2016). Although NS is generally in line with dietary guidelines (Szabo de Edelenyi et al. 2019; Dréano-Trécant et al. 2020; Huybers and Roodenburg 2023), efforts are made to improve its algorithm and achieve a higher degree of coherence with nutritional recommendations (Scientific Committee of the Nutri-Score 2022, 2023).

In the Nordic region, recent studies have evaluated NS in relation to national dietary guidelines (Øvrebø et al. 2023) and to the KH (Pitt et al. 2023; Chan et al. 2025). The Norwegian study applied NS to both solid foods and beverages (Øvrebø et al. 2023). Results indicated a general suitability of this labelling system to rate foods in line with the national dietary guidelines, although conclusions may be difficult to generalise about other countries and contexts. In Sweden, solid foods have mainly been assessed (Pitt et al. 2023; Chan et al. 2025), and it is therefore of interest to expand the analysis to beverages and evaluate how different nutrient quality indicators assess this food category. Therefore, the aim of this study was to evaluate the nutrient quality of beverages commonly consumed in Sweden by applying NS, KH and NRF and qualitatively compare their performance in relation to the dietary guidelines.

Materials and methods

Selection of beverages

A list of beverages commonly consumed in Sweden was obtained from the Swedish food composition database (SFA 2023). The selection was based on the definition of beverages in the updated version of the NS algorithm, i.e. a liquid that is intended to be drunk by humans as part of their diet. This definition includes waters, fruit and vegetable juices, soft drinks, milk, milk-based beverages, fermented milk-based beverages and plant-based beverages. Plant-based beverages refers to products that are based on soy, oat, almond, cashew, rice, coconut, sesame and are used as alternatives to milk (Scientific Committee of the Nutri-Score 2023). The beverage food group in the Swedish food composition database includes beverages that are available on the Swedish market, largely generic and only a minority brand-specific, as well as home-prepared drinks (e.g. cordials). Products targeted to children under the age of three, sport drinks, and beverages intended for medical purposes were excluded from this analysis as they are not eligible for either NS (Sante' Publique France 2023) or the KH (SFA 2022). Similarly, alcoholic beverages with an alcohol content higher than 1.2% were excluded from this study. Additionally, concentrated juices meant to be diluted before consumption were excluded as the corresponding ready-to-drink versions were included in the assessment.

The nutrient composition for the selected beverages was obtained from Swedish food composition database version 2023-06-13. Nutrient composition is given per 100 g product as consumed (i.e. rehydrated for products sold as powder, e.g. instant coffee). Beverages were grouped according to the classification suggested in the NS report (Scientific Committee of the Nutri-Score 2023). Subcategories reflected the main ingredient (e.g. milk vs. water), the presence of added sugar (e.g. flavoured milk-based beverages) and non-nutritive sweeteners. Details of included items and the corresponding categorisation are presented in Appendix Table A1.

Evaluation of nutrient quality

The Nordic Keyhole

The KH symbol is a tool to help consumers identify healthier options within a food group. According to the KH regulation, a product can be labelled with the KH symbol if it belongs to one of 32 food groups (SFA 2022). The food products are eligible or not eligible for the KH based on food group specific criteria for content of fat, sugars, salt, dietary fibre, wholegrain, fruit and vegetables.

Beverages that are included in the KH labelling system (SFA 2022) belong to milk, fermented milk

products and their plant-based alternatives (food group 11). This group can be further divided into two subgroups:

- Group 11.a includes milk and fermented milk products meant to be drunk and not flavoured. Corresponding lactose-free products are also included in this group.
- Group 11.b includes plant-based alternatives to milk and fermented milk products meant to be drunk and not flavoured.

Other beverages are not included in the KH labelling system, regardless of their nutrient profile. For beverages in subgroups 11.a and 11.b, qualification criteria are based on the content of total fat, saturated fat, sugars and salt (Table 1).

Nutri-Score

NS is a numeric nutrient quality score adopted on a voluntary basis in several EU countries. It was originally developed by Julià and Hercberg (2017), subsequently regulated by the French National Agency for Public Health (Sante' Publique France 2023), and reviewed in recent years by a trans-national scientific committee (Scientific Committee of the Nutri-Score 2022, 2023). The NS calculation system is derived from the UK FSA Nutrition Profiling System (FSA 2011). In this study, the updated NS algorithm for beverages was applied, which assigns a score ranging from −15 (better nutrition score) to +40 (worse nutrition score). For each product, the NS algorithm assigns up to +20 points individually for energy (kJ), saturated fatty acids (g), total sugar (g) and sodium (mg); whilst awarding up to −7 points individually for protein (g) and fibre (g), and for fruit, vegetables and legumes combined (g). Additionally, the algorithm assigns +4 points for the presence of non-nutritive sweeteners. For the computation of the fruit, vegetables and legumes component in this study, the SFA's food ingredients database was used. In accordance with the guidelines provided by the French National Agency for Public Health (Sante' Publique France 2023), fruit- and vegetables-based ingredients were considered if they referred to fresh produce, juices or otherwise not specified. Concentrated juices were excluded as contributors to the total fruit, vegetables and legumes proportion in the product. The overall NS value is the sum of the scores from individual components, which are then divided into five classes of nutrient quality ranging from A (green – most healthy, lowest score) to E (red – least healthy, highest score). NS thresholds are presented in Table 1. NS algorithm and NS values for the included beverages are presented in Appendix Tables A3 and A1, respectively.

Nutrient Rich Food index

The quality of beverages was estimated as nutrient density by the Sweden-adapted nutrient density index NRF11.3, which was suggested as a suitable indicator to evaluate the quality of food products with coherence to the Swedish dietary guidelines (Bianchi et al. 2020). NRF11.3 is based on 11 nutrients to encourage (i.e. protein; dietary fibre; vitamins A, C, D and E; folate; magnesium; calcium; potassium; and iron) and three nutrients to limit (i.e. saturated fat, added sugars and sodium). The score for NRF11.3 was calculated by the method initially developed by Fulgoni et al. (2009) and further modified to match the nutritional concerns of the Swedish population (Bianchi et al. 2020; Strid, Hallström, et al. 2021), according to the following equation:

$$\text{Nutrient Rich Foods} = \sum_{i=1}^{x} \frac{Nutrient\ i}{DRI\ i} - \sum_{j=1}^{y} \frac{Nutrient\ j}{MRI\ j} \quad (1)$$

Table 1. Eligibility criteria and threshold values for the application of the Keyhole and Nutri-Score to beverages.

	Keyhole			Nutri-Score		
Food subgroup[a]	Beverages represented	Nutrient criteria	Eligibility	NS thresholds	NS class	NS colour
11.a	Milk and fermented milk products that are meant to be drunk and are not flavoured[b]	Total fat ≤0.7 g/100 g	Yes	Water	A	Dark green
11.b	Plant-based alternatives to milk and fermented milk products meant to be drunk and not flavoured[b]	Total fat ≤1.5 g/100 g	Yes, if all four criteria are met	Min to 2	B	Light green
		Saturated fat ≤33% of total fat		3–6	C	Yellow
		Total sugar ≤5 g/100 g		7–9	D	Light orange
		Salt ≤0.1 g/100 g		10 to max	E	Dark orange

[a]As described in the regulation for the use of Keyhole (SFA 2022).
[b]Corresponding lactose-free products are also represented in subgroups 11.a and 11.b. However, no lactose-free beverages are included in this study, due to lack of nutrient data in the Swedish food composition database.

where x indicates the number of nutrients to encourage and y the number of nutrients to limit, nutrient i/j describes the content of nutrient i or nutrient j per reference unit. DRI is the dietary reference intake of the desirable nutrient i, and MRI is the maximum recommended intake for the undesirable nutrient j. NRF11.3 was calculated for 100 g of food. A mean of sex- and age-specific DRIs and MRIs for the adult population was taken from the Nordic Nutrition Recommendations 2023 (Blomhoff et al. 2023). Nutrients included in NRF11.3, including DRIs and MRIs, are presented in Appendix Table A2. Thus, according to this formula, higher NRF values indicate better nutrient quality compared to lower NRF values. For this study, NRF values were divided into five quintiles where quintile 1 (Q1) and quintile 5 (Q5) included the lowest and highest NRF, respectively.

Evaluation of performance of the nutrient indicators

A high nutrient quality was defined as being eligible for the KH, scoring A or B for NS, and ranking in the top two quintiles (Q4 and Q5) for NRF11.3. A low nutrient quality was defined as not being eligible for the KH, scoring C, D or E for NS, and ranking in the three bottom quintiles for NRF11.3. The indicator which rates beverages with highest coherence to the dietary guidelines (SFA 2017) (e.g. penalising beverages with higher sugar, lower protein or lower vitamin content) was described as most stringent. Agreement between the labelling systems was present if the three of them would align in rating a beverage item as either high or low quality. Disagreement was present if one or more labelling systems would rate a beverage item differently. The KH labelling system is not applicable to milk, milk-based, fermented milk-based and plant-based beverages that are flavoured, which were therefore considered in disagreement when these products agreed for NS and NRF. For non- or low-alcoholic water-based beverages, the level of agreement was only assessed between NS and NRF, as the KH does not apply to this group.

Statistical analysis

Descriptive statistics were used to present frequencies and median (min, max) values. The agreement and disagreement between indicators were assessed using cross-tabulation. All analyses were performed in SPSS (Version 25, SPSS Inc., Chicago, IL).

Results

Nutrient quality of beverages

Results for nutrient quality of beverages are presented in Table 2. A total of 96 beverages were included in the analysis. Of these, 66 were non- or low-alcoholic water-based beverages, and 30 were milk, milk-based, fermented milk-based and plant-based beverages. The largest groups were represented by sugar-sweetened beverages (SSBs) and fruit juices and nectars (both n = 17), followed by coffee, tea and herbal infusions (n = 14).

According to the KH regulation, only 15 beverages were covered by the KH labelling system and therefore assessed for this FOPNL. Of these, eight plant-based beverages and two plain milks were eligible for KH.

All five categories of NS were represented in the assessed beverages, with the following distribution: 30 items qualified for NS B (31% of total), 28 for NS C (29%), 20 for NS E (21%), 14 for NS D (15%) and four for NS A (4%). The healthiest NS score (A) was attributed to waters (by definition, see Table 1), whilst the second most healthy (NS B) was mainly represented by beverages in the coffee, tea, herbal infusions and other grain-based drinks group. These are products that largely contain low or no energy and no added sugar. The least healthy NS score (E) was mostly attributed to SSBs, whilst artificially sweetened beverages mostly qualified for NS C. Half of the fruit juices and nectars assessed qualified for NS C, and all vegetables juices and nectars scored B. Four out of five assessed plain milk products qualified for NS B, with only whole milk qualifying for NS C. Milk-based and fermented milk-based beverages included both plain and flavoured/sweetened products and had a quality varying between NS B and E. Most plant-based beverages qualified for NS C, followed by NS B, E and D.

Nutrient density assessed by NRF11.3 ranged from −0.17 to 0.99 for all beverages. The median nutrient density was highest in fruit juices and nectars (NRF = 0.40), followed by vegetable juices and nectars (NRF = 0.39). Plant-based beverages showed the third highest nutrient density, scoring a median NRF value of 0.37. Beverages with the lowest nutrient density were SSBs (median NRF = −0.11).

Overview of agreement between nutrient quality indicators

Figure 1 and Table A4 show the number of beverage products from the lowest (Q1) to the highest (Q5) quintiles of nutrient density per NS category. Colours

Table 2. Keyhole eligibility, Nutri-Score categorisation and NRF index values of beverage groups.

		Keyhole			Nutri-Score[a] (*n*, %)					NRF 11.3
Beverage group	Number of items	Yes	No	N/A[b]	A	B	C	D	E	Median (min, max)
All beverages	96	10 (10)	5 (5)	81 (84)	4 (4)	30 (31)	28 (29)	14 (15)	20 (21)	0.18 (−0.17, 0.99)
Water-based beverages										
Water	4	0 (0)	0 (0)	4 (100)	4 (100)	0 (0)	0 (0)	0 (0)	0 (0)	−0.00 (−0.04, 0.01)
Sugar-sweetened beverages (SSBs)	17	0 (0)	0 (0)	17 (100)	0 (0)	0 (0)	0 (0)	7 (41)	10 (59)	−0.11 (−0.17, 0.41)
Artificially sweetened beverages	6	0 (0)	0 (0)	6 (100)	0 (0)	0 (0)	5 (83)	1 (17)	0 (0)	0.01 (0.00, 0.18)
Fruit juices and nectars	17	0 (0)	0 (0)	17 (100)	0 (0)	4 (24)	8 (47)	2 (12)	3 (18)	0.40 (0.04, 0.74)
Vegetable juices and nectars	4	0 (0)	0 (0)	4 (100)	0 (0)	4 (100)	0 (0)	0 (0)	0 (0)	0.39 (0.28, 0.75)
Coffee, tea, herbal infusions and other hot grain-based beverages	14	0 (0)	0 (0)	14 (100)	0 (0)	10 (71)	3 (21)	0 (0)	1 (7)	0.03 (−0.04, 0.99)
Low alcoholic (≤1.2%) beverages	4	0 (0)	0 (0)	4 (100)	0 (0)	1 (25)	2 (50)	0 (0)	1 (25)	0.09 (−0.08, 0.17)
Milk-based beverages										
Plain milk	5	2 (40)	3 (60)	0 (0)	0 (0)	4 (80)	1 (20)	0 (0)	0 (0)	0.36 (0.22, 0.39)
Milk-based beverages	8	0 (0)	0 (0)	8 (100)	0 (0)	2 (25)	2 (25)	1 (13)	3 (38)	0.27 (0.13, 0.34)
Fermented milk beverages	4	0 (0)	1 (25)	3 (75)	0 (0)	1 (25)	1 (25)	2 (50)	0 (0.0)	0.13 (0.10, 0.17)
Plant-based beverages	13	8 (62)	1 (8)	4 (31)	0 (0)	4 (31)	6 (46)	1 (8)	2 (15)	0.37 (0.14, 0.53)

[a]NS classes of nutrient quality range from A (most healthy, lowest score) to E (least healthy, highest score). See Table 1 for threshold values.
[b]N/A: not assessed for the Keyhole, as the beverage typology is not included in this labelling system.

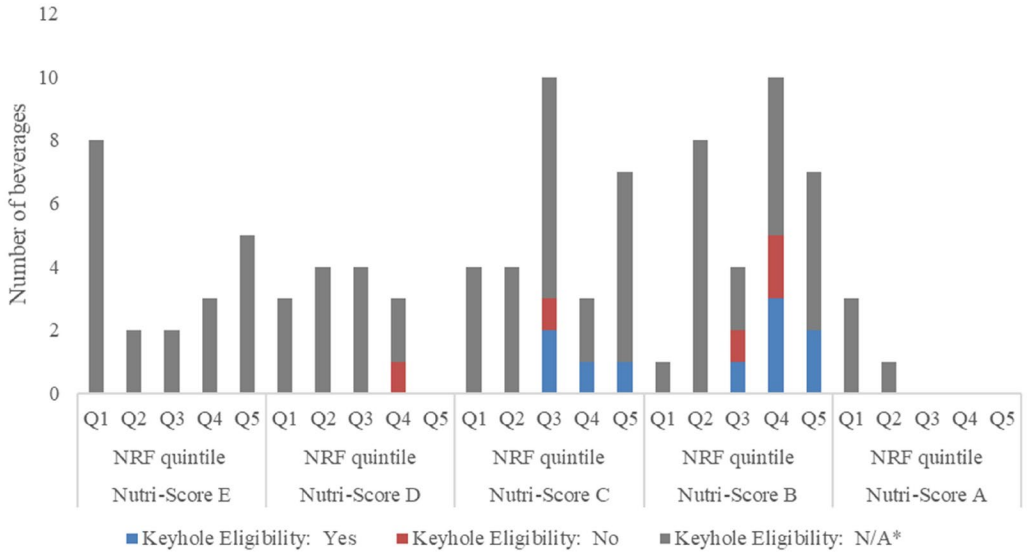

Figure 1. Agreement between nutrient quality indicators across Nutri-Score categories. *N/A: not assessed for the Keyhole, as the beverage typology is not included in this labelling system.

in the bars display the number of items eligible, not eligible or not assessed for the KH. The highest agreement among all three indicators was observed in beverages scoring NS B, where the highest number of beverages with high NRF (Q4 and Q5) (n = 17) and eligibility for KH (n = 6) was observed. However, NS B also included many beverages with low nutrient density (n = 13, in Q1, Q2 and Q3; the second largest number after NS D) and three products not eligible for the KH. High agreement was also present among beverages with low nutrient quality. For example, within beverages scoring D or E for NS, no KH

eligible product and most beverages with very low nutrient density (n = 23 in Q1, Q2 and Q3) were found.

Agreement between nutrient quality indicators in non- and low-alcoholic water-based beverages

Water-based beverages could only be assessed by two nutrient quality indicators, NS and NRF, which aligned in 61% of items (Table 3). Waters showed no alignment between the two indicators, as they were classified as healthiest in NS (NS A) but had a low nutrient density according to NRF.

High alignment was observed in SSBs (88% of items similarly classified), which were mostly rated as low nutrient quality. Only two fruit-flavoured beverages were nutrient dense due to fortification but scored low for NS. Notably, not all fortified drinks were rated as highly nutrient dense (Table A1). Total alignment was observed in beverages containing artificial sweeteners which were similarly classified as having low nutrient quality (Table 3, Table A1).

Among fruit juices and nectars, NRF rated most products as being highly nutrient dense. However, only four beverages qualified for a high NS, which were freshly squeezed citrus fruit juices and a fortified hip rose beverage. Among vegetable juices and nectars, there was disagreement in one product (a tomato juice) which was rated slightly lower for NRF but qualified as high quality for NS (Table 3, Table A1).

Among coffee, tea, herbal infusions and other hot grain-based beverages, only two products qualified as high quality for both NS and NRF (espresso coffee and aloe infusion). Disagreement was observed in 10 beverages, and it was most often explained by a high-quality rating for NS but a low nutrient density (Table 3, Appendix 1). Low-alcoholic beverages were rated low nutrient quality for both NRF and NS, with the only exception of alcohol-free beer which showed NS B whilst having a low nutrient density (Table 3, Table A1).

Agreement between nutrient quality indicators in milk, milk-based, fermented milk-based and plant-based beverages

In all milk- and plant-based beverages, only 20% of products were classified similarly by the KH, NS and NRF (Table 4). Sixty percent of plain milk products and 23% of plant-based beverages were rated similarly by the KH, NS and NRF as having either a high (eligible for KH; NS A or B; top two quintiles for NRF) or a low (not eligible for KH, NS C, D or E; bottom three quintiles for NRF) nutrient quality (Table 4).

Plain milk with a maximum fat content of 0.5% was the milk-based beverage with the most favourable labelling profile, qualifying as high quality for all three indicators. Milk with higher fat content still qualified as high-quality for NS and NRF, except for milk at highest fat content (4.2%) which qualified as low-quality for all three indicators (Table 4 and Table A1).

Milk-based and fermented milk-based beverages showed lower nutrient quality and no simultaneous agreement by all three indicators. No milk-based beverage was included in the KH labelling system, and only one fermented product (a drinkable yoghurt, Ayran-type) was included, and therefore assessed, but

Table 3. The percentage of agreement and disagreement between Nutri-Score and NRF in the assessment of water-based beverages.2011

Beverage group	Agreement Nutri-Score/NRF (%)[a]	Disagreement Nutri-Score/NRF (%)[b]	Reason for disagreement[c]	Notes[d]
All water-based beverages	61	39	1, 2	
Water	0	100	1	Full disagreement. All waters rank low in nutrient density (NRF).
Sugar-sweetened beverages (SSBs)	88	12	2	Disagreement in only two fruit-flavoured fortified beverages where NS is more stringent.
Artificially sweetened beverages	100	0	–	Total agreement between NS and NRF.
Fruit juices and nectars	53	47	2	Disagreement in 8 out of 17 items where NS is more stringent.
Vegetable juices and nectars	75	25	1	Disagreement in only one product (tomato juice) where NRF is more stringent.
Coffee, tea, herbal infusions and other hot grain-based beverages	29	71	1, 2	Disagreement in 10 out of 14 items NRF is more stringent for the majority of products.
Low alcoholic (≤1.2%) beverages	75	25	1	Disagreement in only in one product (alcohol-free beer) where NRF is more stringent.

[a]Agreement defined as a Nutri-Score of A or B and NRF Q4 or Q5 or a Nutri-Score of C, D or E and NRF Q1 or Q2 or Q3.
[b]Disagreement defined as a Nutri-Score of A or B and NRF Q1 or Q2 or Q3 or a Nutri-Score of C, D or E and NRF Q4 or Q5.
[c]Reasons for disagreement—(1) Nutri-Score A or B and NRF Q1 or Q2 or Q3; (2) Nutri-Score C, D or E and NRF Q4 or Q5.
[d]Notes provide further detail on the reason for agreement or disagreement and indicate the nutrient quality indicator that rates beverages with highest coherence with the dietary guidelines.

Table 4. The percentage of agreement and disagreement between keyhole (KH), Nutri-Score and NRF in the assessment of milk, milk-based beverages, fermented milk-based beverages and plant-based beverages.

Beverage group	Agreement Keyhole/ Nutri-Score/ NRF (%)[a]	Disagreement Keyhole/ Nutri-Score/NRF (%)[b]	Reason for disagreement[c]	Notes[d]
All milk- and plant-based beverages	20	80	1, 2, 3,4, 5, 6, 7, 8, 9, 10	
Plain milk	60	40	4	Full agreement (KH/NS/NRF) in milks with fat content ≤0.5% (rated as high quality) and in milk with fat content of 4.2% (rated as low quality). Disagreement in two products (milk with fat content 3% and 1.5%) where KH is more stringent whilst NS and NRF equally rated high quality.
Milk-based beverages	0	100	7, 8, 9, 10	Full disagreement (KH/NS/NRF) as no product could be assessed for KH, due to presence of flavouring NS and NRF disagree in 4 beverages with NS more stringent in most cases.
Fermented milk-based beverages	0	100	6, 8	Full disagreement (KH/NS/NRF). Only one drinkable yoghurt could be assessed for KH and was not eligible. NS and NRF disagree in one drinkable yoghurt, where NRF is more stringent.
Plant-based beverages	23	77	1, 2, 3, 5, 7, 8	Full agreement (KH/NS/NRF) in 3 beverages (enriched soy milk, enriched unsweetened soy and enriched almond milk). KH was not allowed to be assessed in 4 out 13 items. NS and NRF disagree in 7 out of 13 items, where NS is more stringent in most cases.

[a]Agreement defined as Keyhole-eligible, a Nutri-Score of A or B and NRF Q4 or Q5, or not Keyhole-eligible, a Nutri-Score of C, D or E and NRF Q4 or Q5.

[b]Disagreement defined as at least one of the three indicators pointing in the opposite directions compared to the other two.

[c]*Reasons for disagreement*—(1) Qualifying for Keyhole, Nutri-Score A or B, NRF Q1 or Q2 or Q3; (2) qualifying for Keyhole, Nutri-Score C or D or E, NRF Q4 or Q5; (3) qualifying for Keyhole, Nutri-Score C or D or E, NRF Q1 or Q2 or Q3; (4) not qualifying for Keyhole, Nutri-Score A or B, NRF Q4 or Q5; (5) not qualifying for Keyhole, Nutri-Score C or D or E, NRF Q4 or Q5; (6) not qualifying for Keyhole, Nutri-Score A or B, NRF Q1 or Q2 or Q3; (7) Keyhole not applicable, Nutri-Score C or D or E, NRF Q4 or Q5; (8) Keyhole not applicable, Nutri-Score C or D or E, NRF Q1 or Q2 or Q3; (9) Keyhole not applicable, Nutri-Score A or B, NRF Q1 or Q2 or Q3; (10) Keyhole not applicable, Nutri-Score A or B, NRF Q4 or Q5.

[d]Notes provide further detail on the reason for agreement or disagreement and indicate the nutrient quality indicator that rates beverages with highest coherence with the dietary guidelines.

was not eligible. Among both milk- and fermented milk-based beverages, only one product qualified as high quality for both NS and NRF (a drinkable quark), and additionally, in two beverages these labels disagreed (Table 4 and Table A1).

Among plant-based beverages, four items were not included in the KH labelling system, either due to the presence of flavouring or because they were based on sesame as raw material. Fortified soy-based and almond-based drinks showed high quality according to all indicators. The remaining beverages in this group were eligible for the KH, except oat milk with 3% fat. NS classified plant-based beverages more stringently than NRF, with six beverages rating as nutrient dense but not receiving a NS A or B (Table 4 and Table A1).

Discussion

A harmonised front-of-package food labelling entailing both nutrition and sustainability is deemed as a likely scenario in EU and could facilitate the transition towards better human health and more sustainable food systems. Sweden is part of a cluster of Nordic countries with an established use of a regional FOPNL (i.e. the Nordic KH). There is therefore high interest in investigating how the KH relates to other nutrient quality indicators that could flank or even replace its use in Nordic countries. This study offers a case for comparison between the KH and NS in beverages customarily consumed in Sweden. Further, in the present study, the two FOPNLs are compared to the nutrient density index NRF, a measure of nutrient quality commonly used in food sustainability assessments. Results indicate an overall good level of agreement among the three indicators, although the application of the KH to beverages is limited. Further, this study confirms the suitability of NS to rate the nutrient quality of beverages consistent with the dietary guidelines, except for milk where the KH outperforms NS. NRF generally rates beverages less consistent with the dietary guidelines and is to a larger degree influenced by fortification.

This study included both water-based beverages (e.g. soft drinks, fruit and vegetable juices, coffee, tea), dairy-based beverages (e.g. milk, milk-based and fermented milk-based beverages) and their plant-based alternatives (e.g. soy and oat milk). Key nutrient quality attributes in beverages are calorie, sugar and fat content, presence of non-nutritive sweeteners, and the

overall nutrient density, which are to different degrees captured by the three chosen indicators.

A first remark concerns the limited applicability of the KH to beverages (Figure 1). In fact, full comparison of the three indicators was not possible in water-based beverages which are excluded from the KH regulation. This reflects the main dietary advice given to the Swedish population, where water should be the preferred liquid for body hydration (SFA 2017), without emphasis to other drinking options (e.g. fruit juices) which might imply higher calorie or sugar content. However, the KH applies to milk and plant-based alternatives, as dairy is an important component of a healthy diet, and this FOPNL helps the consumer identify healthier options (e.g. lower fat, no added sugar) within this food group. Therefore, considerations on its alignment with the other two nutrient indicators need to be group specific.

Most beverages included in this study scored NS B and C, which can be regarded as high vs. low nutrient quality, respectively. Coherently, most beverages eligible for the KH and with high nutrient density (Q4 and Q5 for NRF) qualified for NS B. Additionally, a consistent number of beverages had very poor quality, as 21% of beverages showed the lowest NS and 60% ranked low for nutrient density (Q1, Q2 and Q3 for NRF). It can therefore be said that the three indicators show a relatively good level of agreement. Agreement was higher among beverages with a low nutrient quality (e.g. among beverages which scored NS D and E, no product was eligible for the KH, and few beverages were nutrient dense), whilst no agreement was present in the case of tap and bottled mineral waters, which scored highest for NS. This is explained by the updated algorithm for NS which attributes score A to water.

Other beverages with high nutrient quality according to NS included coffee, tea and herbal infusions, which are largely low in calorie and contain no added sugar. These products, however, displayed a low nutrient density, which can be explained by lack of fortification. Unlike the NS algorithm, which is mainly based on energy, macronutrients and ingredient components, the NRF index includes several vitamins and minerals and is therefore influenced to a higher degree by fortification. Moreover, coffee and tea are not considered for KH labelling although the Nordic Nutrition Recommendations highlight that a moderate consumption may be part of a healthy diet if the daily maximum intake of caffeine is not exceeded, and if consumed as filtered in the case of coffee (Blomhoff et al. 2023). Notably, among the Swedish population, coffee is the most consumed beverage in men and women, and tea the second most consumed beverage in women (Lemming and Pitsi 2022).

Among water-based beverages, SSBs are most debated due to the significant contribution of added sugar to the diet and the evidence relating high consumption to increased risk of primarily obesity and dental caries in children (EFSA Panel on Nutrition, Novel Foods and Food Allergens (NDA) 2022). Globally, SSBs consumption is higher in younger adults than in older age groups (Singh et al. 2015). Data from national dietary surveys among children and adolescents confirm that SSBs are the largest consumed discretionary food in Norway (Paulsen et al. 2023) and the third source of discretionary calories in Sweden as well as a main source of added sugar (Lindroos et al. 2021). Therefore, dietary recommendations maintain a high focus on advising to limit consumption of SSBs and not exceed 10% energy from free sugars (Blomhoff et al. 2023). Results from this study confirm that NS adequately scored SSBs as nutritionally very poor (NS D and E) and, coherently, these beverages showed the lowest median NRF. However, a few fortified SSBs qualified as nutrient dense according to the NRF index, which indicates that this indicator might be less stringent than NS when classifying fortified products.

Developments in the market indicate that efforts are being made to decrease the sugar content of water-based beverages. In the last 10 years, sales of sugar-free soft drinks increased by 250% and SSBs decreased by 23% in Sweden (The Swedish Brewer Association 2020). This may be indicative of an increased use of non-nutritive sweeteners. Statistics on their use in Sweden is not available; however, it is known that soft drinks are the food category where non-nutritive sweeteners are used the most (Scientific Committee of the Nutri-Score 2023). Although there is still no clear consensus on the beneficial effect of non-nutritive sweeteners on long-term weight regulation or any other long-term health effects within the acceptable level of daily intake (Rios-Leyvraz and Montez 2022), the updated NS algorithm represents a first attempt of integration of non-nutritive sweeteners in a FOPNL. Results from this study describe the quality of a relatively small group of non-nutritive sweeteners-containing beverages, which were all classified as low nutrient quality by NS.

A further consideration should be given about this group of beverages. Soft drinks, together with other discretionary foods, are pointed out as unnecessary contributors to the environmental impact of the diet (Hadjikakou 2017). Their consumption is therefore discouraged both for health and environmental reasons.

Only preliminary research has been conducted on the synergy between NS and ecolabels (Potter et al. 2023) and more research needs to be done to clarify how integrated front-of-package labels can drive a change in consumption, especially among young adults who are high consumers of SSBs and may be a sensitive target to environmental related communication (Sjöberg 2017).

Milk and dairy products are central foods in the Nordic diet, and their role as sources of protein, calcium, iodine, vitamin B12 and D is acknowledged in the nutrition recommendations (Lemming and Pitsi 2022). However, health, and most recently environmental and ethical considerations, are driving a drastic change in consumption. The total consumption of milk in Sweden decreased by 61% in the period 1960–2022 (The Swedish Board of Agriculture 2022). Conversely, the market for plant-based beverages, although still small compared to milk, is rapidly growing, and oat-based beverages are dominating this segment, with an annual growth of 27% in 2019 (Svenfelt and Callmer 2021). This study highlights that the KH classifies plain milk more consistent with the dietary guidelines and might be the most appropriate FOPNL as decreasing the intake of saturated fat is a public health priority. Only milk with low fat content (≤0.5%) was indeed eligible for the KH, whilst NS and NRF rated milk with a higher fat content (up to 3%) as high-quality. It should be noted that milk in Sweden is fortified with vitamin D (except milk with 4.2% fat), and that both this vitamin and calcium are important nutrients accounted for in NRF11.3. Importantly, all three indicators agree on rating milk with 4.2% fat of poorer nutrient quality.

Plant-based beverages included in this study had a more heterogeneous quality, as they are based on different raw materials, present fortification in most cases, and can be flavoured and/or sweetened. Therefore, the KH could only be applied partially to this product category. However, when applied, the KH rated these beverages slightly more favourably than NS, which penalised a few items that were higher in calorie and sugar. Even for this beverage group, NRF was the least stringent among the nutrient quality indicators assessed, and the predominant fortification of products in this category is the likely explanation. Results from the current study therefore could point to an additional but small benefit if the KH would be flanked by NS as FOPNL.

This study is the first in Sweden to apply the updated NS algorithm for beverages and to compare this FOPNL with the KH and NRF. NS rated beverages similarly to what was reported in a recent Norwegian study (Øvrebø et al. 2023). Alignment between the indicators has been estimated in this study by assuming that NS A and B, as well as NRF quintiles 4 and 5, are considered as high nutrient quality. However, it is unclear how Nordic consumers would interpret the NS scale, and whether beverages which rank in the middle (e.g. NS C) would be perceived as healthy. More research is needed in Nordic countries to understand consumers' perception of NS, and its impact on beverage choices, alone and in combination with the KH.

A limitation of this study may be the selection of included beverages, which was based on the Swedish food composition database and therefore not fully representative for all products available on the market. Of note, the fastest growing segment in the beverage sector in Sweden is energy drinks, whose sales have increased by 300% in the last 10 years (The Swedish Brewer Association 2020). However, this group of beverages is under-represented in the Swedish food composition database and only one item could be included in this study.

Further, three nutrient quality indicators were compared in this study, of which two are FOPNLs (KH and NS) with well-established application and calculation criteria. In the case of nutrient density, the NRF index is subjective to several methodological choices, such as the selection of nutrients to include, which can impact the results. However, we used the index variant (NRF11.3) which was shown to be most suitable for studies in the Swedish population (Strid et al. 2021).

Conclusions

The KH is the FOPNL currently available in the Nordic countries, but its application to beverages is limited to unflavoured milk- and plant-based alternatives. This study confirms that this label is the most suited to guide consumers towards milk products with a low-fat content, in line with the dietary recommendations. For plant-based beverages, however, NS may deliver an additional but small benefit in rating beverages in this group most consistent with the dietary guidelines.

NS has a broader applicability than the KH, extending to all beverages with the only exception of alcoholic beverages. Results from this study suggest that NS is suitable to rate the nutrient quality of water-based beverages. According to NS, water, unsweetened beverages (including coffee, tea and herbal infusions), some freshly squeezed fruit juices and vegetable juices qualified as nutritious choices. Coherently, NS appropriately rated sugar-sweetened and non-nutritive sweeteners containing beverages as low nutrient quality. NS can therefore be seen as a useful FOPNL to support healthier choices in this beverage category.

Results from this study show that NRF11.3 rated nutrient quality across beverage groups less stringently (i.e. lower consistency with the dietary guidelines), except for low calorie, largely unfortified products such as coffee, tea and herbal infusions which have low nutrient density. NRF is also highly influenced by fortification and therefore might misleadingly point to fortified beverages with a high sugar content as healthy choices.

Whilst this work highlights the suitability of NS to rate the nutrient quality of beverages, it also points to the need for more studies in Nordic populations to better understand consumers perception of this FOPNL in comparison with the KH label.

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Author contributions

Marta Bianchi: conceptualisation; methodology; writing original draft. Hanieh Moshtaghian: formal analysis; data curation; writing – review and editing. Anna Karin Lindroos: conceptualisation; writing – review and editing. Elinor Hallström: supervision; writing – review and editing. Anna Winkvist: conceptualisation; writing – review and editing; funding acquisition.

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Table A1. List of included beverages, grouping, keyhole eligibility, Nutri-Score rating, NRF median values and quintiles.

Food item	Group	Keyhole (Y/N/N.A.)	Nutri-Score value	Nutri-Score letter[a]	Nutri-Score colour	NRF value	NRF quintile[b]
Soda water	Water	N.A.		A	Dark green	−0.01	1
Vichy water	Water	N.A.		A	Dark green	−0.04	1
Mineral water	Water	N.A.		A	Dark green	0.00	1
Tap water	Water	N.A.		A	Dark green	0.01	2
Fruit drink blueberry fortified	Sugar-sweetened beverages (SSB)	N.A.	11.00	E	Dark orange	0.41	5
Orange cordial RTD fortified	Sugar-sweetened beverages (SSB)	N.A.	8.00	D	Orange	0.16	3
Cordial reduced sugar RTD	Sugar-sweetened beverages (SSB)	N.A.	7.00	D	Orange	−0.11	1
Cordial RTD	Sugar-sweetened beverages (SSB)	N.A.	7.00	D	Orange	−0.11	1
Fruit drink carbonated	Sugar-sweetened beverages (SSB)	N.A.	11.00	E	Dark orange	−0.17	1
Fruit drink still	Sugar-sweetened beverages (SSB)	N.A.	11.00	E	Dark orange	−0.16	1
Soft drink carbonated	Sugar-sweetened beverages (SSB)	N.A.	10.00	E	Dark orange	−0.15	1
Cola	Sugar-sweetened beverages (SSB)	N.A.	12.00	E	Dark orange	−0.16	1
Raspberry cordial RTD	Sugar-sweetened beverages (SSB)	N.A.	11.00	E	Dark orange	−0.13	1
Blackcurrant cordial RTD fortified	Sugar-sweetened beverages (SSB)	N.A.	8.00	D	Orange	0.08	2
Lingonberry drink RTD fortified	Sugar-sweetened beverages (SSB)	N.A.	7.00	D	Orange	0.05	2
Apple drink RTD fortified	Sugar-sweetened beverages (SSB)	N.A.	8.00	D	Orange	0.07	2
Fruit drink rosehip blueberry fortified	Sugar-sweetened beverages (SSB)	N.A.	11.00	E	Dark orange	0.40	5
Energy drink fortified	Sugar-sweetened beverages (SSB)	N.A.	11.00	E	Dark orange	−0.16	1
Swedish soft drink, e.g. Julmust Påskmust	Sugar-sweetened beverages (SSB)	N.A.	9.00	D	Orange	−0.13	1
Slush RTD	Sugar-sweetened beverages (SSB)	N.A.	12.00	E	Dark orange	−0.16	1
Cranberry drink RTD	Sugar-sweetened beverages (SSB)	N.A.	10.00	E	Dark orange	0.04	2
Soft drink carbonated w/ artificial sweeteners	Beverages with NNS	N.A.	4.00	C	Yellow	0.01	2
Diet coke w/ artificial sweeteners	Beverages with NNS	N.A.	4.00	C	Yellow	0.00	1
Cordial artificial sweeteners RTD	Beverages with NNS	N.A.	5.00	C	Yellow	0.04	2
Cordial artificial sweeteners RTD fortified	Beverages with NNS	N.A.	8.00	D	Orange	0.18	3
Swedish soft drink w/ artificial sweeteners, e.g. Julmust light	Beverages with NNS	N.A.	4.00	C	Yellow	0.00	1
Tea fermented w/ artificial sweeteners RTD	Beverages with NNS	N.A.	5.00	C	Yellow	0.01	2
Orange juice freshly-squeezed	Fruit juices and nectars	N.A.	4.00	C	Yellow	0.74	5
Orange juice RTD	Fruit juices and nectars	N.A.	3.00	C	Yellow	0.50	5
Lemon juice freshly-squeezed	Fruit juices and nectars	N.A.	−3.00	B	Green	0.59	5
Small citrus fruit juice freshly-squeezed	Fruit juices and nectars	N.A.	1.00	B	Green	0.53	5
Grapefruit juice freshly-squeezed	Fruit juices and nectars	N.A.	4.00	C	Yellow	0.53	5
Lime juice freshly-squeezed	Fruit juices and nectars	N.A.	−2.00	B	Green	0.51	5

(*Continued*)

Table A1. Continued.

Food item	Group	Keyhole (Y/N/N.A.)	Nutri-Score value	Nutri-Score letter[a]	Nutri-Score colour	NRF value	NRF quintile[b]
Grape juice RTD canned	Fruit juices and nectars	N.A.	9.00	D	Orange	0.17	3
Apple juice RTD	Fruit juices and nectars	N.A.	6.00	C	Yellow	0.05	2
Pineapple juice canned RTD	Fruit juices and nectars	N.A.	8.00	D	Orange	0.32	4
Orange juice RTD pasteurised	Fruit juices and nectars	N.A.	4.00	C	Yellow	0.53	5
Juice	Fruit juices and nectars	N.A.	4.00	C	Yellow	0.41	5
Apricot nectar pasteurised RTD	Fruit juices and nectars	N.A.	11.00	E	Dark orange	0.18	3
Peach nectar pasteurised RTD	Fruit juices and nectars	N.A.	12.00	E	Dark orange	0.04	2
Prune drink canned RTD	Fruit juices and nectars	N.A.	10.00	E	Dark orange	0.40	5
Coconut water	Fruit juices and nectars	N.A.	4.00	C	Yellow	0.31	4
Rosehip soup RTE instant powder w/ o sugar fortified	Fruit juices and nectars	N.A.	2.00	B	Green	0.31	4
Tropical juice RTD	Fruit juices and nectars	N.A.	5.00	C	Yellow	0.16	3
Carrot juice	Vegetable juices and nectars	N.A.	−1.00	B	Green	0.75	5
Tomato juice RTD canned	Vegetable juices and nectars	N.A.	1.00	B	Green	0.28	3
Vegetable juice canned or pasteurised RTD	Vegetable juices and nectars	N.A.	1.00	B	Green	0.39	4
Vegetable juice fermented	Vegetable juices and nectars	N.A.	−3.00	B	Green	0.39	4
Gruel wholegrain fortified	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	3.00	C	Yellow	0.79	5
Instant coffee RTD	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	0.00	B	Green	0.03	2
Coffee brewed	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	0.00	B	Green	0.06	2
Coffee espresso RTD	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	1.00	B	Green	0.29	4
Instant coffee decaffeinated RTD	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	0.00	B	Green	0.00	1
Tea brewed	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	0.00	B	Green	0.03	2
Herbal tea RTD	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	0.00	B	Green	0.01	2
Rosehip tea RTD w/ blackcurrant	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	0.00	B	Green	0.00	2
Aloe vera juice plain	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	0.00	B	Green	0.03	2
Aloe vera juice w/ green tea	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	2.00	B	Green	0.03	2
Aloe vera drink w/ cranberry apple	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	10.00	E	Dark orange	0.99	5
Aloe vera drink plain	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	1.00	B	Green	0.72	5
Tea fermented w/ cane sugar RTD	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	3.00	C	Yellow	−0.04	1
Tea fermented w/ fruit juice RTD	Coffee, coffee substitutes, tea, herbal infusion and other hot cereal and grain-based beverages	N.A.	3.00	C	Yellow	−0.04	1
Cider vol. % 1	Alcoholic beverage	N.A.	12.00	E	Dark orange	−0.08	1
Wine white vol. % 1	Alcoholic beverage	N.A.	3.00	C	Yellow	0.12	3
Wine red or rosé vol. % 1	Alcoholic beverage	N.A.	3.00	C	Yellow	0.17	3
Beer alcohol free vol % 0.5	Alcoholic beverage	N.A.	2.00	B	Green	0.06	2

(*Continued*)

Table A1. Continued.

Food item	Group	Keyhole (Y/N/N.A.)	Nutri-Score value	Nutri-Score letter[a]	Nutri-Score colour	NRF value	NRF quintile[b]
Milk 3% fat fortified	Plain milk	No	2.00	B	Green	0.35	4
Milk non emulsified 4.2% fat, e.g. lantmjölk	Plain milk	No	4.00	C	Yellow	0.22	3
Semi-skimmed milk 1.5% fat fortified	Plain milk	No	−1.00	B	Green	0.36	4
Skimmed milk 0.5% fat fortified	Plain milk	Yes	−1.00	B	Green	0.38	4
Super-skimmed milk <0.1% fat fortified	Plain milk	Yes	−2.00	B	Green	0.39	4
Milkshake chocolate strawberry	Milk-based beverages (including flavoured, sweetened, with NNS)	N.A.	14.00	E	Dark orange	0.13	3
Milk strawberry flavour 1.5% fat fortified	Milk-based beverages (including flavoured, sweetened, with NNS)	N.A.	3.00	C	Yellow	0.24	3
Hot chocolate w/ milk 3% fat	Milk-based beverages (including flavoured, sweetened, with NNS)	N.A.	11.00	E	Dark orange	0.29	4
Hot chocolate w/ milk 1.5% fat	Milk-based beverages (including flavoured, sweetened, with NNS)	N.A.	10.00	E	Dark orange	0.30	4
Hot chocolate w/ milk 0.5% fat	Milk-based beverages (including flavoured, sweetened, with NNS)	N.A.	7.00	D	Orange	0.32	4
Drinking chocolate w/ water	Milk-based beverages (including flavoured, sweetened, with NNS)	N.A.	2.00	B	Green	0.19	3
Drinking chocolate RTD	Milk-based beverages (including flavoured, sweetened, with NNS)	N.A.	6.00	C	Yellow	0.19	3
Drinking quark diff. flavours	Milk-based beverages (including flavoured, sweetened, with NNS)	N.A.	−2.00	B	Green	0.34	4
Yoghurt drinkable flavoured 1% fat	Fermented milk products intended to be drunk (including plain, flavoured, sweetened, with NNS), termed fermented milk-based beverages	N.A.	7.00	D	Orange	0.14	3
Yoghurt drinkable flavoured app. 1% fat app. 8% sugar	Fermented milk products intended to be drunk (including plain, flavoured, sweetened, with NNS), termed fermented milk-based beverages	N.A.	5.00	C	Yellow	0.17	3
Yoghurt drinkable flavoured app. 1% fat app. 11% sugar	Fermented milk products intended to be drunk (including plain, flavoured, sweetened, with NNS), termed fermented milk-based beverages	N.A.	8.00	D	Orange	0.10	2
Yoghurt drink, e.g. Ayran	Fermented milk products intended to be drunk (including plain, flavoured, sweetened, with NNS)	No	2.00	B	Green	0.13	3
Oat drink chocolate 1.5% fat fortified	Milk analogues	N.A.	12.00	E	Dark orange	0.38	4
Oat drink 1.5% fat fortified	Milk analogues	Yes	5.00	C	Yellow	0.36	4
Soy drink	Milk analogues	Yes	−5.00	B	Green	0.21	3
Sesame drink water extract of seeds w/ husk	Milk analogues	N.A.	4.00	C	Yellow	0.37	4
Sesame drink water extract of seeds w/o husk	Milk analogues	N.A.	3.00	C	Yellow	0.14	3
Soy drink fortified	Milk analogues	Yes	0.00	B	Green	0.33	4
Almond drink fortified	Milk analogues	Yes	4.00	C	Yellow	0.48	5
Oat drink 1.5% fat organic fortified	Milk analogues	Yes	5.00	C	Yellow	0.19	3
Oat drink 0.5% fat organic fortified	Milk analogues	Yes	5.00	C	Yellow	0.20	3
Oat drink chocolate 2.5% fat fortified	Milk analogues	N.A.	10.00	E	Dark orange	0.47	5
Oat drink 3% fat fortified	Milk analogues	No	7.00	D	Orange	0.37	4
Soy drink w/o sugar fortified	Milk analogues	Yes	−5.00	B	Green	0.51	5
Almond drink w/o sugar fortified	Milk analogues	Yes	1.00	B	Green	0.53	5

N.A.: not applicable; RTD: ready to drink.
[a]NS A: highest nutrient quality; NS E: lowest nutrient quality.
[b]Q1: lowest nutrient quality; Q5: highest nutrient quality.

Table A2. Nutrients included in the nutrient density index NRF113 and the daily recommended values according to the Nordic Nutrition Recommendations 2023 (Blomhoff et al. 2023).

Nutrients to encourage	DRI[a]
Protein[b] (g)	91.0
Fiber[c] (g)	30.5
Vitamin A (RE)	750.0
Vitamin C (mg)	102.5
Vitamin D (µg)	10.0
Vitamin E (αTE)	10.5
Folate (µg)	330
Calcium (mg)	950
Magnesium (mg)	325
Potassium (mg)	3500
Iron (mg)	12.0
Nutrients to limit	**MRI[a]**
Added/free sugars[d] (g)	60.6
Saturated fat[e] (g)	27.0
Sodium (mg)	2300

DRI: dietary reference intake; intake covering the needs of 97.5% of a healthy adult population; MRI: maximum recommended intake; RE: retinol equivalents; αTE: α-tocopherol equivalents; %E: percentage energy.
[a]Average values for men and women aged 25–70 years with an average level of physical activity (9800 kJ/day). When a range or a different recommended intake is given for different age or sex groups, the highest value is considered in the average calculation.
[b]Based on 15 E%.
[c]Based on 3 g/MJ/day.
[d]Based on 10 E%.
[e]Based on 10 E%.

Table A3. Components included in the calculation of Nutri-Score for beverages with thresholds and corresponding points attributed (Scientific Committee of the Nutri-Score 2023).

Nutri-Score = *A component* − *C component*								
	Favourable elements (together forming the *C component*)			Unfavourable elements (together forming the *A component*)				
Points	Proteins (g per 100 mL)	Fibres (g per 100 mL)	Fruit, vegetable, legume (%)	Energy (kJ per 100 mL)	Sugar (g per 100 mL)	Saturated fat (g per 100 mL)	Salt (g per 100 mL)	Non-nutritive sweeteners (presence/absence)
0	≤1.2	≤3		≤30	≤0.5	≤1	≤0.2	
1	>1.2	>3		≤90	≤2	>1	>0.2	
2	>1.5	>4.1		≤150	≤3.5	>2	>0.4	
3	>1.8	>5.2		≤210	≤5	>3	>0.6	
4	>2.1	>6.3		≤240	≤6	>4	>0.8	Presence
5	>2.4	>7.4		≤270	≤7	>5	>1	
6	>2.7			≤300	≤8	>6	>1.2	
7	>3			≤330	≤9	>7	>1.4	
8				≤360	≤10	>8	>1.6	
9				≤390	≤11	>9	>1.8	
10				>390	>11	>10	>2	
11							>2.2	
12							>2.4	
13							>2.6	
14							>2.8	
15							>3	
16							>3.2	
17							>3.4	
18							>3.6	
19							>3.8	
20							>4	

Table A4. Agreement between nutrient quality indicators across Nutri-Score categories.

			Keyhole eligibility (*n*)			
			Yes	No	N/A[a]	Tot (*n*/*Q*)
Nutri-Score E	NRF quintile	Q1	–	–	8	8
		Q2	–	–	2	2
		Q3	–	–	2	2
		Q4	–	–	3	3
		Q5	–	–	5	5
Nutri-Score D	NRF quintile	Q1	–	0	3	3
		Q2	–	0	4	4
		Q3	–	0	4	4
		Q4	–	1	2	3
		Q5	–	–	–	0
Nutri-Score C	NRF quintile	Q1	0	0	4	4
		Q2	0	0	4	4
		Q3	2	1	7	10
		Q4	1	0	2	3
		Q5	1	0	6	7
Nutri-Score B	NRF quintile	Q1	0	0	1	1
		Q2	0	0	8	8
		Q3	1	1	2	4
		Q4	3	2	5	10
		Q5	2	0	5	7
Nutri-Score A	NRF quintile	Q1	–	–	3	3
		Q2	–	–	1	1
		Q3	–	–	–	0
		Q4	–	–	–	0
		Q5	–	–	–	0

[a]N/A: not assessed for the Keyhole, as the beverage typology is not included in this labelling system.