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Algorithm Matters: The Impact of the 2023 Nutri-Score Revision (NS-NPM) on the Nutritional Classification of Kombucha Products Worldwide

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Received: July 14, 2026; **Published:** July 23, 2026

Abstract

Introduction and Methodology: In response to criticisms and recognised limitations of the Nutri-Score Nutrient Profiling Model (NS-NPM), the algorithm was revised in December 2023. This study compared the nutritional classification of kombucha beverages using the original and revised NS-NPM algorithms based on global data from the Open Food Facts Foundation database. Kombucha products recorded in the Open Food Facts database were analysed using datasets from April 2023 and April 2026. Products evaluated under the original and revised Nutri-Score algorithms were identified and compared. To distinguish the effect of the algorithm revision from that of product reformulation, a subset of 775 products with identical nutritional composition was re-evaluated using both algorithms.

Results: In the April 2023 database, 1,463 of 2,673 kombucha products were evaluated using the original Nutri-Score algorithm, with 57% classified as Nutri-Score A/B/C and 43% as D/E. In the April 2026 database, 1,971 of 3,928 products were evaluated using the revised NS-NPM algorithm, of which 93% were classified as A/B/C and only 7% as D/E. Re-evaluation of the 775 nutritionally identical products showed that the proportion classified as A/B/C increased from 54% to 92%, indicating that this improvement was primarily attributable to the revised algorithm rather than to product reformulation.

Conclusion: Although the revised NS-NPM did not introduce criteria specifically designed for hybrid beverages such as kombucha, it established new distinctions between sugar-sweetened and artificially sweetened drinks. These revised sugar thresholds substantially improved the Nutri-Score classification of kombucha products. The findings demonstrate that changes in nutrient profiling algorithms can markedly alter product ratings without any modification in nutritional composition. This has important implications not only for product reformulation and consumer beverage choices, but also for consumer confidence in front-of-pack nutrition labelling and the credibility of food-rating platforms.

Keywords: *Kombucha; Hybrid Fermented Tea Beverage; Probiotic Beverage; Nutri-Score Food Classification*

Introduction

Nutrition classification schemes (NCSs) and front-of-pack nutrition labelling systems have become important public health tools for promoting healthier food choices and encouraging product reformulation [1-3]. Among these, Nutri-Score is one of the most widely implemented nutrient profiling models in Europe [4-7], providing consumers with a simple five-level classification (A-E) based on the nutritional composition of foods and beverages. However, concerns have been raised regarding the performance of the original algorithm, particularly for beverages and some processed foods [11-13].

To address these limitations, the Nutri-Score Nutrient Profiling Model (NS-NPM) was revised in December 2023, introducing new scoring criteria and beverage-specific thresholds to improve the nutritional discrimination of drinks based on their sugar content and overall nutritional profile. The revised algorithm is being progressively implemented across participating countries through 2026 [14,15].

Kombucha is a fermented tea beverage that has experienced rapid global market growth owing to increasing consumer interest in functional beverages [16,17]. Although traditionally produced by fermenting sweetened tea with a symbiotic culture of bacteria and yeast (SCOBY), commercial kombuchas exhibit considerable variability in sugar content and frequently contain added ingredients or sweeteners [18-21]. Consequently, kombucha is a hybrid food whose nutritional evaluation can vary substantially depending on the classification framework used and may even be classified as an ultra-processed food by systems such as NOVA or SIGA despite its fermented origin [22,23].

The revision of the NS-NPM provides a unique opportunity to examine how methodological changes alone may influence the nutritional classification of hybrid foods without any modification in product composition or food category. Using identical kombucha products from the Open Food Facts Foundation database, this study compared classifications obtained with the original and the revised 2026 NS-NPM algorithms to evaluate the impact of the algorithm update on nutritional classification.

Materials and Methods

Nature and production process of kombucha

Kombucha is a slightly acidic, naturally carbonated beverage produced by fermenting sweetened tea with a symbiotic culture of bacteria and yeast (SCOBY). Traditionally, it is prepared from black or green tea (*Camellia sinensis*) [18,19]. Over the past decades, kombucha has gained worldwide popularity owing to its perceived functional properties and potential health benefits, including antioxidant, digestive, and immunomodulatory effects [20].

Although traditional kombucha is tea-based, numerous studies have explored alternative substrates such as fruits, herbs, and plant extracts. Regardless of the substrate used, the SCOBY remains the key driver of the fermentation process, determining the beverage's physicochemical and sensory characteristics. As a result, the commercial market has diversified considerably and now includes a wide range of kombucha products, reflecting the rapid industrial expansion of this beverage and the growing need for harmonised regulatory frameworks [16,17,24].

Open food facts database

The nutritional components and food classification information were sourced from the OpenFoodFacts.app database, which is available at https://world.openfoodfacts.org. The OpenFoodFacts app is a collaborative initiative focusing on globally traded food products. This database operates under an Open Database License (ODBL) and encompasses comprehensive nutritional data, including ingredients and allergens, mirroring the information typically found on product labels. The data utilised for this study were retrieved from the OpenFoodFacts database in April 2023 and April 2026. Any duplicates or distinct presentations of products with identical compositions and brands were systematically excluded from the analysis to ensure accuracy.

Nutri-score system and algorithm update

The Nutri-Score system, developed in 2014 by a group of French scientists led by Serge Hercberg, is a front-of-pack labelling model that classifies the nutritional quality of foods using a five-letter, colour-coded scale (A-E) [4,5]. Adopted in several European countries [6,7], it aims to provide consumers with a quick, simple interpretation of the nutritional profiles of food products. However, the system has been criticised for failing to consider factors such as the degree of food processing, which is why its algorithm is continually being revised.

In December 2023, an updated Nutri-Score algorithm (NS-NPM) was introduced, with progressive implementation planned through 2026 [14,15]. The new model incorporates stricter criteria for beverages, including stronger penalties for sugar, salt, saturated fat, and intense sweetener content, thereby avoiding overly favourable classifications for ultra-processed or "light/zero" products. However, the updated algorithm still does not specifically address other sweeteners, such as polyols, which are commonly used in kombucha [22]. Taken together, these findings suggest that revisions to nutrient profiling algorithms can substantially influence the nutritional classification of foods independently of changes in product composition.

Although the revised Nutri-Score criteria for beverages do not specifically address hybrid beverages such as kombucha and kefir. The updated scoring rules for sugars and sweeteners may indirectly affect their classification. Consequently, changes in Nutri-Score ratings may reflect modifications to the algorithm rather than actual improvements in the nutritional composition of kombucha products.

Statistical analysis

Statistical analyses were performed using Stata v.18.0, accounting for the diversity of kombucha formulations and presentations across the countries studied. Due to the non-normal distribution of the variables, nonparametric methods were applied, including the Mann-Whitney U test, the chi-squared test, and the interquartile range (IQR, 25% - 75%) [25]. Statistical significance was established at $p < 0.05$ for all analyses.

Results

Analysis of the 2023 database: Nutri-score (Original algorithm)

The author previously conducted the first global analysis of kombucha products listed in the OpenFoodFacts database (April 2023; n = 2,673 brands), which was subsequently published in a peer-reviewed journal [13]. Of these products, 1,463 (55% of the total sample) were evaluated using the original Nutri-Score algorithm. Among them, 833 products (57%) were classified into the most favourable categories (A, B, or C), considered healthy in this study, whereas 630 products (43%) were assigned to the least favourable categories (D or E), considered unhealthy. The distribution of nutritional and energy components across categories, together with the differences identified using the Mann-Whitney test, is presented in table 1.

2023	Nutri-Score A/B/C Median (p25-p75) (n = 833) (57%)	Nutri-Score D/E Median (p25-p75) (n = 630) (43%)	Mann-Whitney z	p-value
Energy (kcal/100 ml)	11.3 (8.0-14.00)	19.00 (16.9-24.00)	-28.81	0.001*
Carbohydrates (g/100 ml)	2.60 (1.9-3.4)	3.4 (2.5-5.0)	-25.58	0.001*
Sugars (g/100 ml)	2.3 (1.1-2.9)	4.0 (3.6-4.6)	-26.23	0.001*

Table 1: *Principal nutritional component of kombucha assessed by nutri-score (2023).*

**Significant difference (p < 0.05)*.*

Analysis of the 2026 database using the updated nutri-score algorithm (NS-NPM)

To evaluate the impact of the revised Nutri-Score algorithm, the author reanalysed the updated global OpenFoodFacts kombucha database de 2026 (April 2026; n = 3,928 brands). Of these products, 1,971 (50% of the total sample) were evaluated. Of these, 1,840 products (93%) were classified into categories A, B, or C, whereas only 131 products (7%) were assigned to categories D or E. The distribution of nutritional and energy components across categories, together with the differences between groups assessed using the Mann-Whitney test, is presented in table 2.

2026	Nutri-Score A/B/C Median (p25-p75) (n = 1840) (93%)	Nutri-Score D/E Median (p25-p75) (n = 131) (7%)	Mann-Whitney z	p-value
Energy (kcal/100 ml)	15 (11-19)	45 (19.84-260)	-12.79	0.001*
Carbohydrates (g/100 ml)	3.5 (2.5-4.4)	9 (4.12-39.86)	-11.74	0.001*
Sugars (g/100 ml)	3.0 (2.0-4.0)	8.15 (3.61-44.00)	-11.56	0.001*

Table 2: *Principal nutritional component of kombucha assessed by nutri score (2026).*

**Significant difference ($p < 0.05$)*.*

Longitudinal analysis of nutritional reclassification (2023-2026)

A longitudinal comparison of the 2023 and 2026 OpenFoodFacts databases identified 775 kombucha products present in both datasets via statistical matching. Although the nutritional composition of these products remained unchanged, their Nutri-Score classification changed substantially following the introduction of the revised NS-NPM algorithm. The proportion of products classified as healthy (Nutri-Score A, B, or C) increased from 54% in 2023 to 92% in 2026, demonstrating that revisions to the nutrient profiling algorithm alone can markedly alter product ratings without any underlying change in nutritional composition.

Discussion

The analysis of the results shows that, according to the Nutri-Score system, the share of products classified as healthy (Categories A/B/C) increased from 57% in 2023 using the previous algorithm to 93% in 2026 with the new algorithm (NS-NPM). Given that the data were derived from different databases, comparisons should be interpreted with caution due to potential statistical limitations, and the results should therefore be considered indicative. The observed increase was statistically significant (From 57% to 93%; $\chi^2 = 480.5$; $p < 0.001$). Overall, these findings suggest that the application of the new algorithm (NS-NPM) yields a predominantly favourable nutritional classification for kombucha, with approximately 90% of products considered healthy.

The nutritional profiles of kombucha products classified using the original (2023) and revised (2026) Nutri-Score algorithms showed that energy, carbohydrates, and sugars were the main determinants of classification. After implementation of the revised NS-NPM, the median energy and sugar contents of the A/B/C and D/E categories increased because the revised beverage-specific sugar thresholds redistributed the same products between Nutri-Score categories rather than reflecting changes in product composition. In the A/B/C categories, median energy increased from 11.3 to 15.0 kcal/100 ml and sugars from 2.3 to 3.0 g/100 ml, while in the D/E categories, energy increased from 19.0 to 45.0 kcal/100 ml and sugars from 4.0 to 8.1 g/100 ml. These findings indicate that because kombucha contains few nutrients beyond energy, carbohydrates, and sugars, the revised sugar thresholds were the principal drivers of its reclassification. Despite these changes, even products classified as D/E remained below the World Health Organisation threshold of 10 g of free sugars per 100 ml for sugar-sweetened beverages, although higher-sugar products should still be consumed with caution by individuals with impaired carbohydrate metabolism.

Among the 1,397 products identified in both database versions, 775 met the criteria for direct comparison under the updated NS-NPM algorithm. Application of the revised algorithm resulted in a marked redistribution of Nutri-Score categories, increasing the proportion of kombuchas rated A/B/C from 54% to 92%, despite no changes in product composition. As this longitudinal comparison was restricted to an identical matched cohort of products, the observed reclassification is attributable to modifications in the scoring algorithm rather than to differences in the underlying dataset.

Finally, products such as soy beverages and plant-based meat alternatives highlighted limitations of the former Nutri-Score system, as they were often perceived as healthy despite being classified as ultra-processed foods [11]. The updated NS-NPM algorithm has partially improved the classification of these products. In the case of kombucha, hybrid products have not yet been specifically reclassified, as kombucha remains difficult to categorise due to the complexity of its industrial processing and the frequent use of additives such as polyols. This issue will likely require additional revisions in upcoming algorithm updates. Nevertheless, the new model has had a significant impact because many kombucha varieties contain moderate sugar levels (approximately 2 - 8 g/100 ml), lower than those of conventional soft drinks. The stricter sugar criteria have substantially improved their nutritional ratings, particularly in low-energy and reduced-sugar varieties. As a result, nearly 90% of kombuchas achieved a healthy classification, further supported by the growing presence of light, vegan, and functional products.

Conclusion

The new Nutri-Score algorithm (NS-NPM) was implemented in December 2023, with progressive implementation planned through 2026. Classifies approximately 90% of kombuchas as healthy or recommended products. This increase compared with the classification obtained using the previous algorithm could be explained, on the one hand, by the automatic reclassification resulting from the new NS-NPM model, particularly due to the revised assessment of sugar content, and, on the other hand, by the recent introduction of new kombucha varieties (vegan, organic), with more favourable nutritional profiles into the market.

The carbohydrate and sugar content of kombuchas classified as unhealthy under the new nutritional categories, with mean values close to 8 g/100 ml, remains below the WHO recommended limit for soft drinks (< 10 g/100 ml). Nevertheless, their consumption should be approached with caution in individuals with diabetes or metabolic syndrome. Furthermore, these findings suggest that a more favourable Nutri-Score classification does not necessarily reflect a genuine improvement in nutritional quality. Moreover, although the revised algorithm introduced changes in the evaluation of sugars and sweeteners, it still does not specifically account for other sweeteners, such as polyols, which are commonly used in kombucha beverages.

Beyond kombucha, this study shows that revisions to nutrient profiling algorithms can substantially alter nutritional classifications independently of changes in product composition. As front-of-pack nutrition labels play an increasingly important role in consumer decisions, food reformulation, and public health policies, algorithm updates should be carefully considered when interpreting nutritional ratings and temporal trends in food quality. These findings provide relevant evidence for the future development of nutrition labelling systems and evidence-based food policies.

Declaration of AI Use

ChatGPT, an OpenAI language model (version GPT-5.5, 2026), was used to support the writing process and improve clarity in certain sections of the article. It was not used to generate or alter the research results.

Conflicts of Interest

The author declares that they have no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement, etc.) that might pose a conflict of interest in connection with the submitted article.

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Volume 21 Issue 5 May 2026