



The triad of fibre, sodium and saturated fat as decisive factors of a healthy diet: A cross-sectional study on nutrient profile and nutritional quality of processed foods

Murat GÜRBÜZ¹, Selinay DEMİREL², Esma Nur ERDOĞAN², Miray Nur AYKUT²

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¹ Niğde Ömer Halisdemir University,
Department of Nutrition and Dietetics,
51000, Niğde/Türkiye

² Trakya University, Department of
Nutrition and Dietetics, 22000,
Edirne/Türkiye

ORCID IDs of the authors:

M.G. 0000-0001-7778-7524
S.D. 0009-0009-7023-2142
E.N.E. 0009-0002-1844-7890
M.N.A. 0009-0005-1579-401

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ABSTRACT

The present study aimed to monitor the amounts of fibre, sodium and saturated fat in Turkey's food supply and determine the number of processed foods with labelling information for these components. Additionally, this study aimed to determine the nutritional quality of the foods based on declared labelling information. This was a cross-sectional study of 2676 products from January-April 2023. Products with partial and complete nutrient declarations were expressed as numbers and percentages. Fibre, sodium, and saturated fat amounts were expressed as median, interquartile range, and range. The nutritional quality of the food products was assessed using a Health Star Rating system. The information about labels for fibre, sodium, and saturated fat was 61.4%, 23.1%, and 97.1%, respectively. The median fibre, sodium, and saturated fat in all food products were 1.60 g, 76 mg, and 2.30 g/100 g, respectively. The food categories with the least fibre content were "milk and dairy products" and "non-alcoholic beverages." Conversely, the highest sodium and saturated fat content categories were "sauces and broths" and "snack foods," respectively. Based on the declared composition of food products, the median Health Star Rating score was 2.0, with 70.9% considered less healthy. Although Turkey has made progress in line with global developments, more effort is needed to improve the composition of certain processed foods.

Keywords: Fiber, Sodium, saturated fat, Nutritional quality, Processed foods

Correspondence:

Murat GÜRBÜZ

E-mail: muratgurbuz@ohu.edu.tr



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Introduction

The concept of processed food has negative connotations among consumers and researchers. Processing refers to the methods used to transform fresh food into products and consists of one or more steps (European Food Information Council, 2017). First, processing was designed to address the challenges of the long-term storage and transport of foods. Further, it can provide extra benefits regarding palatability, fortification and safety of foods (Petrus et al., 2021; Rogers & Amer, 2022). On the other hand, the combination of components such as fat, sugar, and salt in some processed foods gives the food a rewarding characteristic and triggers over-consumption (Lustig, 2020). Therefore, it may be useful to explain the NOVA classification system, which categorises foods into four groups according to the level of processing. Group 1 refers to unprocessed and minimally processed foods. After separating from nature, this group includes the edible parts of plants or animals. Group 2 refers to processed culinary ingredients, including oils, lard, butter, sugar, and salt. Group 3 refers to processed foods and includes products with salt, sugar, or other additives added to group 1 foods to make them more stable and palatable. Group 4 refers to ultra-processed foods and consists of products containing formulations created using various industrial techniques and processes (Petrus et al., 2021).

Higher consumption of processed food, especially ultra-processed foods, has been associated with higher risks of obesity, type 2 diabetes mellitus, cardiovascular disease, and cerebrovascular disease (Chen et al., 2020; Srouf et al., 2019). These foods have a high energy density, high saturated fats and sodium content, and low amounts of dietary fibre (Lustig, 2020). The association between high-quality dietary patterns, such as the Mediterranean Diet and Dietary Approaches to Stop Hypertension, and a lower risk of non-communicable chronic diseases has already been reported (Esposito et al., 2015; Rosato et al., 2019). Unlike most processed foods, such dietary patterns provide a more balanced nutrient profile, such as high dietary fibre, low sodium, and low saturated fatty acids (Dicken & Batterham, 2021). In this context, public health policies have aimed to reformulate the ingredients of unhealthy energy-dense and processed foods because of the increased evidence of a causal relationship between healthy dietary patterns and reduced disease risk.

Turkey has initiated ingredient reformulation in processed foods, which aligns with global developments. For example, a "Cooperation Protocol on Reducing Excessive Salt Consumption" was signed between the Ministry of Health and the Federation of Food and Beverage Associations to improve the

composition of food products through reformulation (Republic of Turkey Ministry of Health, 2021). Additionally, reformulation strategies and targets for components such as saturated fat and sugar in the food supply are intended to be extended in line with the European Food and Nutrition Action Plan (World Health Organization, 2015). However, no studies have monitored the components of processed products sold in Turkey, such as fibre, sodium and saturated fat, and assessed the nutritional quality of foods in the food supply. Additionally, there is no standardised labelling information for packaged processed products in Turkey. Labelling is an important tool for informing consumers and monitoring reformulation practices. Therefore, the aim of the present study was to monitor the amounts of fibre, sodium and saturated fat in Turkey's food supply and to determine the number of packaged processed foods with labelling information for these components. This study also aimed to determine the nutritional quality of food products based on declared labelling information.

Materials and Methods

This cross-sectional study included all packaged processed food products in leading retail stores in Edirne, located in European Turkey. As the types of processed food products available in these stores may vary in each chain, we visited each chain of stores throughout the city. We also visited local markets in high- and lower-middle-income neighbourhoods to increase food diversity.

Data Collection

During the period from January to April 2023, a total of 2676 packaged products were collected for the present study. Information regarding the labels of the food products included name, brand, nutritional facts, and ingredients. Information on name, brand, nutritional facts, and ingredients was obtained from the product labels. Products without the labelling information required by the Turkish Food Codex were excluded from the study. The researcher photographed the packaged products and uploaded the images to a cloud-based server to aid in data collection. The data from these products was then extracted and inputted into Microsoft Office Excel 2016 by hand. Subsequently, each product was registered separately based on the product categories specified by the researchers.

Data Categorization

The products included in the study conformed to the guidelines of the Turkish Food Codex Regulation on Food Labelling and Consumer Information, including brand, label, approval number, net content of the product, legible ingredients, recommended consumption date, and country of origin. Trained dietitians and nutritionists categorised the products into nine major food groups and 50 subgroups (Table 1). These included (a) milk and dairy products, (b) meat and meat products, (c) oils, oil seeds and nuts, (d) confectionery and sweets, (e) bread, cereals and bakery goods, (f) snack foods, (g) non-alcoholic beverages, (h) sauces and broths, and (i) miscellaneous (Supplementary Table 1).

Data on Product Labelling and Food Composition

As there is no standardised labelling information for food products in Turkey, we first determined whether the products had a partial or complete nutrient declaration during the data entry. All products with any label information for at least one fibre, sodium or saturated fat were included in the study. The declared amounts of nutrients per 100 g of food products were recorded. The Turkish Food Codex requires that the nutritional labels of packaged foods include the labelling of salt content but not the labelling of sodium content (Turkish Food Codex, 2017). If the product label did not indicate the sodium content, the sodium content of the products was calculated to be 39.3% of the salt content.

Calculating the Health Score of Products

The health score of food products was calculated using the Health Star Rating (HSR) system. The HSR system was developed in Australia in 2014 and has been widely used in many studies (Dickie et al., 2020). This system functions based on the food products' energy, total sugar, fibre, saturated fat, sodium, protein, fruit and vegetable, nut, and legume contents. The HSR system can categorise many food products but is not useful for baby foods, sports supplements, alcoholic beverages, and medical foods.

The HSR system uses a scale ranging from 0.5 to 5 stars but does not offer a cut-off point separating healthy foods from unhealthy foods. However, some studies have categorised food products as unhealthy if their scores were below 3.5 (Bayram and Ozturkcan, 2021; Dickie et al., 2020). Therefore, an HSR score of 3.5 was considered a cut-off point reflecting a "healthy pass" in the present study.

Assignment of Traffic Light Criteria for Saturated Fat

All foods with label declarations were assessed for saturated fat content and categorised as low, medium, or high according to the Food Standards Agency criteria (Food Standards Agency, 2016). Low, medium, and high contents were colour-coded green, yellow, and red, respectively. Red indicates a high saturated fat content, meaning these foods should be consumed less often and in smaller amounts. Yellow indicates a medium saturated fat content, meaning these foods can be consumed mostly if they contain lower amounts of other nutrients of concern (e.g., sugar and sodium). Finally, green indicates a low saturated fat content, which means that these foods are healthier in terms of saturated fat. The number of each coloured product in the main food categories was expressed as a percentage.

Table 1. Label information of processed food products sold in Turkey according to major food categories

Categories	Total number of products [n, %]	Fibre [n, %]	Sodium [n, %]	Saturated fat [n, %]
Milk and dairy products	383 (14.3)	140 (36.5)	107 (27.9)	380 (99.2)
Meat and meat products	104 (3.9)	12 (11.5)	102 (98.1)	101 (97.1)
Oils, oil seeds and nuts	203 (7.6)	110 (54.2)	7 (3.4)	201 (99.0)
Confectioneries and sweets	442 (16.5)	234 (52.9)	21 (4.7)	422 (95.5)
Bread, cereals and bakery	100 (3.7)	81 (81.0)	0 (0.0)	99 (99.0)
Non-alcoholic beverages	493 (18.4)	401 (81.3)	332 (67.3)	458 (92.9)
Snack foods	409 (15.3)	379 (92.7)	10 (7.3)	409 (100)
Sauces and broths	62 (2.3)	9 (14.5)	30 (48.4)	62 (100)
Miscellaneous	480 (17.9)	276 (57.5)	9 (1.9)	467 (97.3)
Total	2676	1642 (61.4)	618 (23.1)	2599 (97.1)

Statistical Analyses

Mathematical calculations and figures were performed using GraphPad Prism 6.0 (GraphPad Software, Inc., La Jolla, CA, USA). The number and percentage of products with partial and complete nutrient declarations were performed using Excel® 2007 software (Microsoft Co., Redmond, Washington, DC, USA) and reported with the "COUNTIF" formula overall and by category. The amount of fibre, sodium, and saturated fat was expressed as median, interquartile range and range for all major food categories and products in each category. The products' sodium contents in 100 g were categorised according to the World Health Organization (WHO) criteria targets.

Results and Discussion

General Comments

Labelling food products is a crucial mechanism facilitating interaction between food manufacturers and customers while enabling traceability for food companies and regulatory bodies. As shown in Table 1, the percentages of food products labelled with fibre, sodium and saturated fat were 61.4, 23.1 and 97.1%, respectively. The food categories with the most label declarations for fibre and sodium were "snack foods" and "meat and meat products". In contrast, the food categories with the fewest label declarations were "meat and meat products" and "bread, cereals, and bakery goods". According to the Turkish Food Legislation Codex Regulation, the labelling of commercial food products for saturated fat and salt is compulsory, whereas it is not compulsory for fibre and sodium (Turkish Food Codex, 2017). Despite being compulsory, 2.9% of the food products did not meet the label declaration criteria for saturated fat.

Identifying the number of a food's components, such as fibre, sodium, and saturated fat, can provide valuable insights into the potential health implications of consuming that food. The present study found that the median fibre, sodium, and saturated fat scores in all food products were 1.60 g, 76 mg, and 2.30 g/100 g, respectively (Table 2). Our findings on the amount of these components were similar to those commonly sold in the United States, Canada and Australia (Ahuja et al., 2017; Franco-Arellano et al., 2018; Lowery et al., 2020). Data on the nutrient content of processed foods may vary from country to country; therefore, an international comparison of

these data can improve reformulation practices. However, information on food composition alone does not provide insight into whether the food is healthy for most consumers.

Over the past few years, several governments and organisations have implemented packaging labels that display the nutritional quality of food products through symbols and colours. These label practices may guide consumers to choose healthier foods. Moreover, these labels can improve the dietary patterns of populations through product reformulation (Lowery et al., 2020; O'Mahony et al., 2023). The HSR system, developed in Australia, is an important tool that displays the nutritional quality of food products, assigning them a rating from 0.5 to 5.0 stars. Dickie et al. (2020) monitored the 5-year HSR score of processed food products supplied in Australia and found that the current HSR median score of food products was 3.5. Additionally, the authors reported that 32.8% of these food products were less healthy, with a median HSR score of < 3.5 (Dickie et al., 2020). There has been no system or initiative to determine the nutritional quality of food products sold in Turkey. According to our findings, the median HSR score was 2.0, and 70.9% of these products were less healthy (Table 3).

Fibre

The dose-dependent inverse relationship between processed food consumption and dietary fibre intake has been well recognised (Schönenberger et al., 2023). Dietary fibre has been attributed to several physiological effects, such as increasing faecal bulk, protecting colon health, regulating serum cholesterol and glucose levels, lowering blood pressure, and providing weight management. Furthermore, adding fibre can reduce the product's fat, cholesterol, and energy content and improve properties such as hydration, viscosity, texture, and sensory properties (Elleuch et al., 2011). For these reasons, the food industry increasingly relies on adding fibre to processed food products, as it offers enhanced structural properties and several health benefits. There are many reports in the literature on adding fibre to food products, such as bakery goods, confectionery, dairy products, meat products, and ready-to-eat dishes (Elleuch et al., 2011; O'Mahony et al., 2023). There has been no official initiative to increase the fibre content of processed foods sold in Turkey. However, some companies are reformulating their products and introducing healthier alternatives.

Table 2. An examination of the nutrient content in food products offered by major food groups and categories

Categories	Fiber Content [g/100g]			Sodium Content [mg/100 g]			Saturated Fat Content [g/100g]		
	Median	IQR	Range	Median	IQR	Range	Median	IQR	Range
Milk and dairy products									
Milk	0.4	0.8	0.0-1.3	20.0	0.0	0.0-400.0	1.0	0.7	0.0-2.3
Yoghurt	0.0	0.0	0.0-0.0	30.0	60.0	0.0-200.0	2.2	1.3	0.4-10.0
Ayran	-	-	-	280.0	0.0	240.0-320.0	1.2	0.3	1.0-1.5
Kefir	0.0	0.0	0.0	30.0	40.0	0.0-300.0	1.6	1.0	0.0-2.20
Cheese	0.0	0.0	0.0	640.0	440.0	0.0-2280.0	13.2	5.9	0.0-25.0
Cream	0.0	-	0.0	20.0	40.0	0.0-80.0	16.4	11.2	9.6-22.8
Kaymak	0.0	0.0	0.0	0.0	40.0	0.0-120.0	39.0	12.0	8.1-43.5
Butter	-	-	-	0.0	0.0	0.0-760.0	48.0	0.0	48.0-51.3
İce-cream	0.6	0.5	0.0-2.5	70.0	20.0	20.0-100.0	4.8	6.4	0.0-13.0
Dessert	0.4	2.9	0.0-3.7	100	150.0	40.0-200.0	4.4	6.5	1.5-8.8
Total	0.0	0.4	0.0-3.7	60.0	540.0	0.0-2280.0	3.6	11.9	0.0-51.3
Meat and meat products									
Red meat products	1.5	-	1.0-2.0	800.0	200.0	280.0-4000.0	12.0	11.0	0.6-25.0
Poultry products	2.4	2.0	0.0-2.5	600.0	300.0	280.0-960.0	4.2	4.4	0.3-23.0
Sea products	1.5	1.7	0.0-2.0	340.0	640.0	0.0-1400.0	1.2	2.9	0.0-13.0
Total	2.0	1.7	0.0-2.5	680.0	320.0	0.0-4000.0	5.2	10.3	0.0-25.0
Oils, oil seeds and nuts									
Oils	0.0	-	0.0	0.0	80.0	0.0-200.0	17.0	3.0	0.0-45.0
Oil seeds	10.0	4.0	0.5-23.9	500.0	780.0	0.0-7200.0	6.3	4.2	0.01-19.9
Oil emulsions	0.8	1.15	0.3-2.0	580.0	340.0	120.0-1200.0	4.6	4.4	0.2-9.1
Nut butters	3.6	3.9	0.4-13.0	80.0	180.0	0.0-380.0	8.1	5.8	0.8-16.4
Total	6.7	7.3	0.0-23.9	200.0	600.0	0.0-7200.0	7.2	6.2	0.0-45.0
Confectioneries and sweets									
Confectionery	1.80	3.58	0.00-15.30	36.0	115.0	0.0-1.00	6.81	17.90	0.00-35.00
Chewing gums	0.00	0,40	0.00-1.60	0.0	25.0	0.0-100.0	0.00	0.03	0.00-0.22
Pastry jelly and sweet sauces	1.30	3.12	0.00-4.64	48.0	58.0	0.0-400.0	0.00	2.30	0.00-3.30
Powder dessert mixes	0.45	2.55	0.00-6.30	56.0	196.0	0.0-640.0	2.70	2.94	0.50-12.06
Jams and marmaledes	0.60	0.80	0.00-2.60	0.0	0.0	0.0-200.0	0.00	0.00	0.00-5.50
Pekmez	0.20	1.00	0.00-1.50	0.0	80.0	0.0-160.0	0.00	0.00	0.00-0.10
Honey	0.00	0.15	0.00-0.20	0.0	16.0	0.0-4.500	0.00	0.00	0.00-0.00
Other sweets	3.40	5.94	0.00-8.80	4.0	82.0	0.0-498.0	5.10	6.68	0.00-31.30
Total	0.80	2.70	0.00-15.30	24.0	88.0	0.0-4.500	0.80	6.05	0.00-35.00
Breads, cereals and bakery									
Packaged breads	5.1	4.7	1.6-14.2	360.0	200.0	10.0-1320.0	0.9	1.2	0.1-4.0
Cereals	7.8	5.2	3.1-18.0	150.0	240.0	0.0-440.0	1.3	0.9	0.0-7.5
Bakery products	6.0	7.6	0.9-17.4	360.0	400.0	0.0-1600.0	3.7	4.7	0.2-14.2
Total	6.3	5.2	0.9-18.0	320.0	370.0	0.0-1600.0	1.8	3.1	0.0-14.2
Non-alcoholic beverages									
Carbonated drinks	0.0	0.0	0.0-0.0	0.0	0.0	0.0-10.0	0.0	0.0	0.0-0.0
Fruit juices	0.0	0.0	0.0-3.3	0.0	0.0	0.0-40.0	0.0	0.0	0.0-0.8
Energy drinks	0.0	0.0	0.0-0.0	40.0	80.0	0.0-80.0	0.0	0.0	0.0-0.8
Mineral water	0.0	0.0	0.0-0.0	10.0	0.0	0.0-110.0	0.0	0.0	0.0-0.0
Ice tea and coffee	0.0	0.0	0.0-0.5	0.0	40.0	0.0-200.0	0.0	0.6	0.0-1.7
Powdered drinks	2.6	10.7	0.0-60.2	100.0	240.0	0.0-2400.0	5.1	7.0	0.0-31.0

Other drinks	0.0	0.0	0.0-0.9	0.0	50.0	0.0-680.0	0.0	0.1	0.0-2.1
Total	0.0	0.0	0.0-60.2	0.0	40.0	0.0-2400.0	0.0	0.8	0.0-31.0
Snack foods									
Packaged cakes	1.80	1.20	0.60-5.60	320.0	120.0	10.0-600.0	10.18	3.90	0.10-19.00
Biscuits	2.90	2.80	0.30-11.00	250.0	170.0	0.0-1120.0	10.00	4.40	1.30-21.00
Crackers	2.90	2.37	1.20-12.25	990.0	440.0	400.0-7750.0	8.15	4.42	0.30-13.00
Chips	3.90	1.50	0.50-31.30	560.0	200.0	20.0-1200.0	10.00	12.75	0.30-54.80
Wafers	2.30	1.45	0.00-11.00	160.0	80.0	4.0-320.0	15.60	6.00	9.60-29.80
Bars	12.80	4.00	1.31-17.50	16.0	150.0	0.0-252.0	2.45	2.00	0.00-9.00
Total	3.10	2.50	0.00-31.30	288.0	360.0	0.0-775.0	10.19	7.10	0.00-54.80
Sauces and broths									
Cooking sauces	3.70	1.20	2.50-3.70	760.0	840.0	0.0-6240.0	0.20	1.00	0.00-10.60
Broths	0.95	2.85	0.00-3.00	20000.0	728.0	11080.0-20720.0	6.50	8.30	5.70-14.00
Total	2.50	3.25	0.00-3.70	820.0	1010.0	0.0-20720.0	0.30	2.80	0.00-14.00
Miscellaneous									
Ready-to-eat dishes	0.65	3.77	0.00-14.50	480.0	2340.0	0.0-7080.0	1.10	1.65	0.00-11.40
Baby foods	1.75	0.92	0.10-3.80	10.0	20.0	0.0-220.0	0.04	0.40	0.00-1.40
Canned foodstuff	2.00	6.50	0.00-15.00	400.0	400.0	0.0-3160.0	0.00	0.00	0.00-5.00
Frozen foodstuff	2.00	1.45	0.22-9.20	390.0	450.0	0.0-2800.0	4.10	6.77	0.00-20.30
Milk substitutes	0.40	0.80	0.00-1.20	40.0	40.0	0.0-40.0	0.20	0.30	0.10-0.90
Dry fruits	5.75	7.42	0.00-8.40	0.0	0.0	0.0-210.0	0.10	0.20	0.00-1.30
Sport bars	10.15	4.45	6.00-13.20	100.0	150.0	0.0-640.0	2.65	2.72	1.10-4.90
Total	2.20	4.00	0.00-15.00	400.0	600.0	0.00-7080.0	0.80	1.56	0.00-20.30
TOTAL	1.60	3.90	0.00-60.20	76.0	400.0	0.00-20720.0	2.30	9.36	0.00-54.80

Table 3. Health Star Rating (HSR) scores for processed food products sold in Turkey according to major food categories

Categories	Median	IQR	Range	HSR<3.5	
				n	%
Milk and dairy products	4.00	2.50	0.50-5.00	50	35.97
Meat and meat products	2.75	2.38	1.00-4.00	7	63.63
Oils, oil seeds and nuts	3.00	3.00	0.50-5.00	56	61.53
Confectioneries and sweets	1.50	2.00	0.50-4.50	151	83.42
Breads, cereals and bakery	4.00	1.00	1.50-5.00	11	13.75
Non-alcoholic beverages	1.50	1.50	0.50-3.50	439	93.60
Snack foods	1.50	1.00	0.50-5.00	318	84.13
Sauces and broths	2.00	1.00	0.50-3.00	62	100
Miscellaneous	3.50	3.00	0.50-5.00	61	28.37
Total	2.00	2.00	0.50-5.00	1154	70.9

The fibre content of food products sold in Turkey varies widely owing to differences in food processing levels and fibre addition practices. Our results showed that minimal or unprocessed foods were a better dietary source of fibre than ultra-processed foods, as expected. "Oils, oil seeds and nuts," "bread, cereals and bakery goods" and "snack foods" were the major food categories containing the most fibre with median scores of 6.7, 6.3, and 3.1 g/100 g, respectively. Conversely, "milk and dairy products", "non-alcoholic beverages, and "confectionery and sweets" were the major food categories containing the least fibre, with median scores of 0.0, 0.0, and 0.8 g/100 g, respectively. The use of fibre in dairy products is a common practice. For example, inulin added to cheese, fermented milk products, and ice cream is used in fat substitutes, textural modifications, and organoleptic improvements (Karimi et al., 2015). In our study, cheese and fermented milk products were devoid of fibre, whereas ice cream had various dietary fibre content with a median score of 0.6 g/100g.

Current dietary guidelines recommend reducing the consumption of grain-based processed foods with low fibre content owing to adverse health outcomes. Based on the carbohydrate/fibre ratio of whole wheat flour, the American Heart Association recommends consuming food products with a ratio of $\leq 10:1$ (Mozaffarian et al., 2013). A recent investigation into the nutritional content of bread and cereals in four major supermarkets in the United Kingdom found that products with this specific ratio were reported to have good nutritional quality (Ghodsian & Madden, 2018). Our findings showed that cereals (mean: 11.3; SEM: 1.3) and bread (mean: 12.9; SEM: 2.1) did not meet the specific ratio requirement. Although categorised as ultra-processed foods, only bars (mean: 6.9; SEM: 1.6) and sports bars (mean: 4.3; SEM: 0.6) of grain-based food products met the $\leq 10:1$ criterion, probably because of their fruit, nut, and oilseed content (Figure 1).

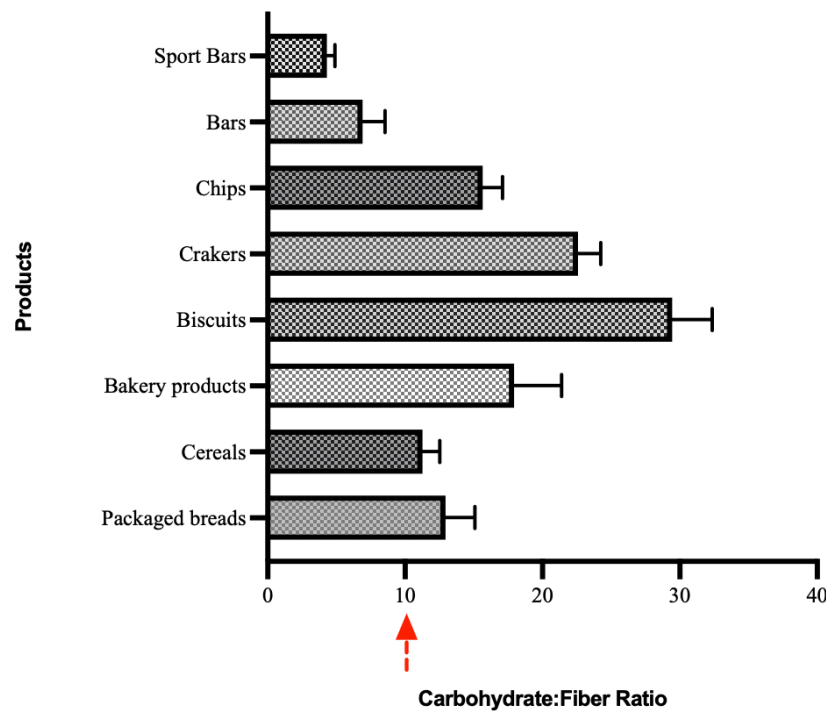


Figure 1. Carbohydrate: Fibre Ratio of Grain-Based Food Products

Sodium

Poor dietary patterns, such as Western-type diets, which include a high proportion of processed packaged foods, contribute to excessive sodium intake (Dicken & Batterham, 2021). The most important dietary source of sodium is salt, and excessive salt intake increases the risk of high blood pressure, a major risk factor for cardiovascular diseases (Srouf et al., 2019). As indicated by the Chronic Diseases Risk Factors Survey conducted by the Ministry of Health, approximately 24% of the adult population in Turkey is diagnosed with hypertension (Republic of Turkey Ministry of Health, 2013). The World Health Organization recommends a maximum intake of 5 g salt (or 2000 mg sodium) daily. However, the Dietary Guidelines for Turkey recently reported an average daily salt intake of 9.4 g for adults (Dietary Guidelines for Turkey, 2022). As part of WHO's Global Action Plan, Turkey has adopted a global target of a 30 per cent reduction in the average sodium intake of the population (World Health Organization, 2015). Although Turkey has taken some actions, such as signing a co-operation protocol to reduce excessive salt consumption between the Ministry of Health and the Federation of Food and Beverage Associations, the sodium content of food products sold in Turkey is still quite high.

As shown in Table 2, the sodium content of the food products analysed on the labels ranged from 0.0 to 20720.0 mg/100 g. This range is similar to most processed foods in the United Kingdom (Ni Mhurchu et al., 2011). The food product with the highest sodium content was "broths", with a median score of 20000 mg/100 g. In Australia, the sodium content of broths was reported to be 16920 mg/100 g, which is approximately 20% less than the sodium content of broths sold in Turkey (Grimes et al., 2011). Crackers (990 mg/100 g), red meat products (800 mg/100 g), cooking sauces (760 mg/100 g) and cheeses (640 mg/100 g) are also food products with high sodium content. Typically, food products with high sodium content, such as processed red meat, butter, cheese, cereals and snack foods, have the greatest variation in sodium content among countries. In our study, "butter" and "cereals" had lower sodium content than in other countries, with median scores of 0.0 and 150.0 mg/100 g, respectively, while meat products, cheese and snack foods had similar sodium content (Arcand et al., 2019; Webster et al., 2010).

In 2011, the Turkish Ministry of Health introduced a program to reduce the salt content of certain food products, including bread, olives, cheese, and tomato paste, as part of its salt reduction strategy (Republic of Turkey Ministry of Health, 2016). However, processed foods remain one of the important

contributors to the high sodium intake of the population (Erdem et al., 2017). In 2020, the WHO began creating global benchmarks for sodium content in various food categories. In many studies, such as ours, the sodium content of food products in the main food categories was heterogeneous. The WHO set benchmarks at the level of subcategories to minimise this heterogeneity. Therefore, we redesigned these subcategories, which needed a global benchmark, and compared the sodium levels of food products with the WHO standards. As shown in Table 4, sodium levels exceeded WHO targets in all subcategories except "cookies and sweet biscuits", "highly processed breakfast cereals", "butter and other fats", and "comminuted meat products (non-heat preservation)". All products in the "frozen potatoes" subcategory exceeded the sodium limits, while 92.3% of products in the "butter and other fats" subcategory complied with the global standards.

Saturated Fat

Animal-based products such as meat and dairy products and processed food products such as packaged cakes, chips and biscuits are the main sources of saturated fat in the food supply (Dicken & Batterham, 2021; Lustig, 2020). Overconsumption of saturated fats is a significant risk factor for the development of cardiovascular disease, which is currently the primary cause of mortality in Turkey (Turkish Statistical Institute, 2024). Dietary Guidelines for Turkey, in line with WHO, recommend reducing saturated fat intake to less than 10 per cent of total energy intake (Dietary Guidelines for Turkey, 2022). Substituting saturated fats with monounsaturated and polyunsaturated fats is associated with a decreased risk of cardiovascular disease (Guasch-Ferré et al., 2015). Recently, many countries such as Norway, Australia and Italy have established agreements with the food industry to reduce the saturated fat content of processed food products (Nourishing Database, 2022).

Turkish cuisine is rich in traditional foods with a high saturated fat content, such as kaymak, sucuk, and tahin (sesame butter). For example, "kaymak" has long been an indispensable breakfast food for many people in Turkey and was found to have the second highest saturated fat content after butter in our study, with a median score of 39.0 g/100 g. However, when examined according to the main food categories, snack foods had the highest saturated fat content with a median score of 10.2g/100g (Table 2). Our research showed that the amount of saturated fat in snack foods such as packaged cakes, biscuits, and crackers was considerably higher than in other countries (Ahuja et al., 2017; Crino et al., 2018). Awareness of the level of saturated fat on the labels of processed foods may be important for individuals at high risk of

noncommunicable chronic diseases such as cardiovascular disease. Reporting saturated fat profiles of processed foods is also important when comparing countries or regions.

In the present study, we classified the amount of saturated fat in food products according to the criteria of the Food Standards Agency. We calculated the percentages of red, amber, and green-coloured foods in the main food categories. As shown in Figure 2, the main food category "snack foods" had

the lowest percentage of healthier options (5.14%). It was followed by "oils, oil seeds and nuts," "meat and meat products" and "milk and dairy products" with 5.42, 18.27 and 28.98% respectively. Turkey has made progress in reducing the amount of trans fats in processed foods, but it should now focus on reducing the amount of saturated fats. Although there is concern about the high consumption of processed foods, reformulating certain products with a high saturated fat content can result in products with a healthier profile.

Table 4. Sodium level classification of food products sold in Turkey according to WHO's Global Sodium Benchmarks

Categories	Sodium amount [mg/100g]			Classification	Products over the limit
	Median	IQR	Range		
Crackers and savoury biscuits	992.0	440.0	0.0-7750.0	High	42 (89.4)
Cookies and sweet biscuits	244.0	164.0	0.0-1120.0	Low	47 (41.6)
Snack cakes	320.0	362.0	0.0-600.0	High	52 (80.0)
Nuts, seeds and kernels	500.0	780.0	0.0-7200.0	High	64 (62.8)
Potato, vegetable and grain chips	560.0	200.0	16.0-1200.0	High	52 (64.2)
Highly processed breakfast cereals	152.0	240.0	0.0-440.0	Low	5 (18.5)
Fresh unripened cheese	400.0	200.0	0.0-1200.0	High	36 (92.3)
Soft to medium-ripened cheese	720.0	280.0	0.0-1480.0	High	73 (78.5)
Semi-hard ripened cheese	920.0	560.0	400.0-2280.0	High	10 (83.3)
Canned foods	400.0	270.0	0.0-2000.0	High	57 (75.0)
Ready-to-eat meals	480.0	2300.0	0.0-7080.0	High	154 (82.3)
Butter and other fats	80.0	120.0	0.0-760.0	Low	2 (7.7)
Bread and bread products	460.0	330.0	12.0-1600.0	High	49 (87.5)
Canned fish	1700.0	2030.0	200.0-8200.0	High	18 (90.0)
Processed fish and seafood products (raw)	336.0	500.0	0.0-1400.0	High	7 (50.0)
Raw meat products and preparations	480.0	360.0	320.0-800.0	High	9 (90.0)
Whole muscle meat products (non-heat preservation)	2500.0	1980.0	1560.0-4000.0	High	4 (80.0)
Comminuted meat products (cooked)	600.0	300.0	280.0-1200.0	High	25 (69.4)
Comminuted meat products (non-heat preservation)	800.0	80.0	520.0-920.0	Low	3 (10.7)
Pickled vegetables	800.0	1480.0	0.0-3160.0	High	19 (54.3)
Frozen potatoes	420.0	360.0	360.0-800.0	High	4 (100)
Bouillon and soup stock (concentrated)	20000.0	7280.0	11080.0-20720.0	High	5 (71.4)
Cooking sauces	760.0	840.0	0.0-6240.0	High	59 (98.3)
Emulsion-based dips, sauces and dressings	640.0	270.0	280.0-8.000	High	11 (78.6)

Limitations and Strengths

The study has some limitations. The study was limited to Edirne, and the results may vary among different cities in the country. Second, our findings are derived solely from the nutritional information and list of ingredients as declared on the product label. Third, although we have analysed the data meticulously, a few minor human errors may have occurred. Fourth, no evidence suggests that a score of ≥ 3.5 on the HSR

system is predictive of positive health outcomes. Furthermore, limited evidence suggests that the HSR system leads to improved food choices. Despite these limitations, this is the most extensive study in Turkey that reports the number of essential nutrients, which are crucial determinants of health, in processed and packaged food products and classifies the quality of products in the country's food supply to the best of our knowledge.

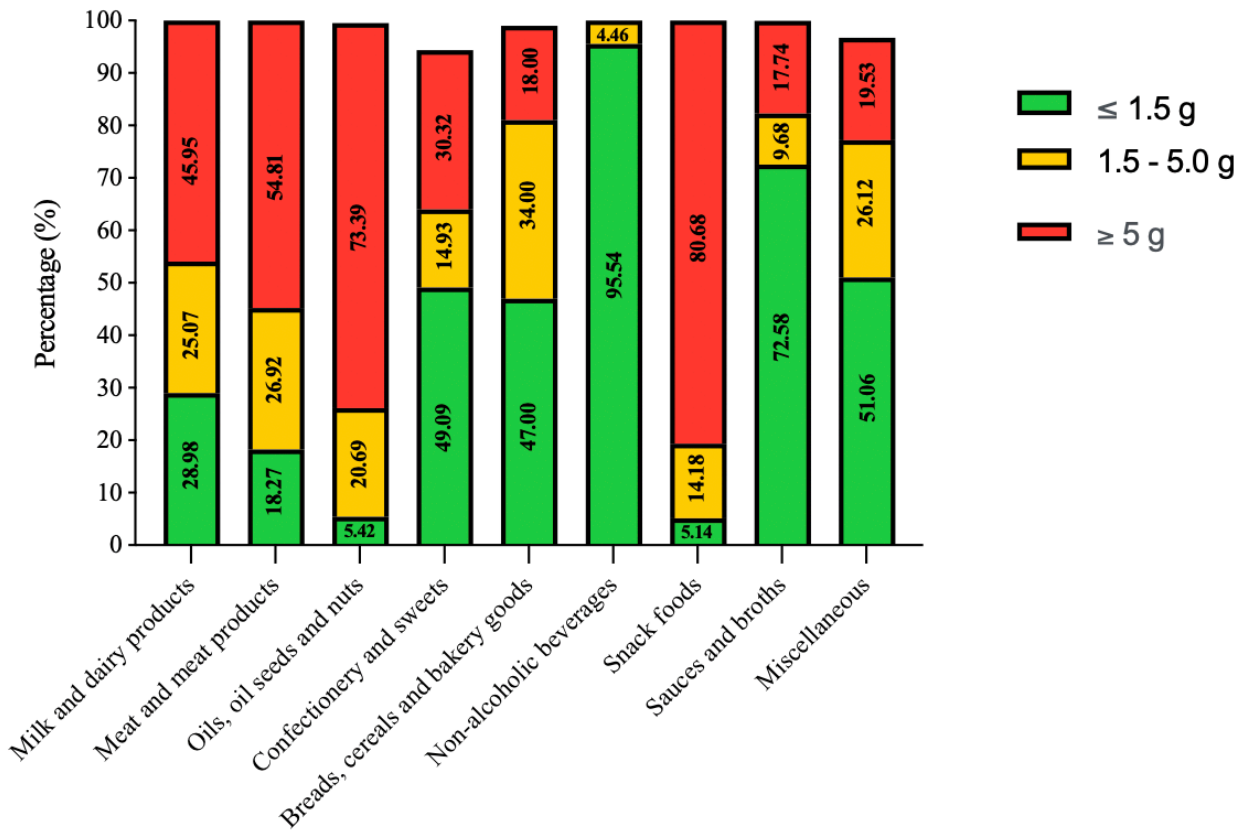


Figure 2. Traffic light percentages of saturated fat in food categories according to the Food Standards Agency's criteria

Conclusion

The label information for fibre, sodium, and saturated fat was 61.4%, 23.1%, and 97.1%, respectively. The main food categories containing the least fibre were "milk and dairy products" and "non-alcoholic beverages". In contrast, the main food categories with the highest sodium and saturated fat content were "sauces and broths" and "snack foods", respectively. Based on the declared composition of food products, the median HSR score was 2.0, and 70.9% of these products were less healthy. Although Turkey has no official initiatives to increase the fibre content in processed foods, some initiatives have been launched to reduce sodium content in processed foods in line with global trends. Additionally, Turkey plans to expand its reformulation strategies to include saturated fat components. The implementation of the reformulation strategy alone will not be sufficient to guarantee that the public adopt healthier dietary habits. However, reforming processed foods can lead to products with a healthier profile and may encourage people to adopt more sustainable consumption habits.

Compliance with Ethical Standards

Conflict of interest: The author(s) declares that they have no actual, potential, or perceived conflict of interest for this article.

Ethics committee approval: The authors declare that this study does not include experiments with human or animal subjects, so ethics committee approval is not required.

Data availability: Data will be made available on request.

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Disclosure: -

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