MAGYAR AGRÁR- ÉS ÉLETTUDOMÁNYI EGYETEM

Hungarian University of Agriculture and Life Sciences

NUTRITIONAL GASTRONOMY IN FOCUS: READY-TO-EAT MEALS, NUTRITIONAL VALUE AND CONSUMER ATTITUDES

Mohannad AlOudat

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The PhD School

Name: Doctoral School of Food Science

Discipline: Food Science

Head: **Prof. Dr. Livia Simon Sarkadi, DSc**
Institute of Food Science and Technology
Hungarian University of Agriculture and Life Sciences

Supervisor: **Dr. Andrea Lugasi, PhD**
Department of Hospitality
Budapest Business School Faculty of Commerce, Hospitality and Tourism

Co-supervisor: **Prof. Dr. Livia Simon Sarkadi, DSc**
Institute of Food Science and Technology
Hungarian University of Agriculture and Life Sciences

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Approval of the Head of Doctoral School **Approval of the Supervisor(s)**

1. INTRODUCTION

Maintaining wellbeing and reducing the risk of non-communicable diseases (NCDs) greatly rely on a varied and balanced diet, emphasizing healthy food choices. The World Health Organization (WHO) recognizes the importance of diet and recommends adequate nutrient intake and biologically active compounds. However, the growing prevalence of imbalanced diets, resulting from excessive energy consumption, has led to a rise in obesity and NCDs worldwide.

This thesis focuses on the study of gastronomy, specifically investigating the healthiness of ready-to-eat (RTE) meals in Hungary. Gastronomy encompasses various disciplines such as nutrition, food science and technology, and palatability, which collectively influence food processing and preparation methods. By maximizing the nutritional value and natural biologically active compounds of food, it is possible to enhance its health benefits while maintaining its desirable characteristics and properties.

The availability of RTE meals has increased due to the demand for convenient food options, driven by time constraints and busy lifestyles. The global market for RTE meals was valued at $98.12 billion in 2019, with Europe being the largest contributor. However, RTE meals are often associated with higher levels of energy, fat, saturated fat, and sugar, as well as lower levels of essential micronutrients, potentially contributing to weight gain and associated health issues.

Furthermore, the impact of the food environment extends beyond RTE meals to include restaurants and food services. The reliance on these establishments for meals has increased, and the menus they offer can significantly influence consumers' health. The restaurant industry in the European Union alone accounted for over €600 billion in household spending in 2018. This highlights the need to understand how menu creators, including chefs and establishment owners, can positively impact consumers' health and lifestyle choices.

In the context of gastronomy traditions and cultural practices, the nutritional value of mixed dishes and cuisines can vary due to factors such as ingredients, geography, and climate. This variability has implications for public health, emphasizing the need to assess the healthiness of RTE meals within the Hungarian context.

By investigating the nutritional profile of RTE meals in Hungary and considering the influence of gastronomic traditions on their palatability and nutritional composition, this thesis aims to shed light on the health implications of consuming these meals. Additionally, it explores the perception of chefs regarding health and nutrition, acknowledging their potential role in shaping consumers' dietary habits and lifestyle choices.

The research conducted in this study fills a critical gap in the current understanding of the healthiness of RTE meals in Hungary. While existing research has primarily focused on food safety aspects, this thesis expands the knowledge base by examining the nutritional aspects and the intersection between gastronomy traditions and RTE meals. By integrating scientific evidence and gastronomic expertise, this study seeks to provide valuable insights for consumers, healthcare practitioners, food industries, and researchers, ultimately promoting healthier dietary habits and lifestyle choices among the population.

2. OBJECTIVES

Since gastronomy is a complex concept, the overall aim of the thesis was to evaluate the healthiness of RTE meals in Hungary as a recent trend in the food industry based on its nutritional profile, the effect of gastronomy traditions on RTE meals in terms of palatability and nutritional profile, and chefs' perception on health and nutrition. To achieve this overall aim, I carried out investigations with the following specific objectives:

I. To compare the energy content and macronutrients of forty main popular traditional and modern meals in both Jordan and Hungary with the international recommendations, where nutrients were calculated using two different nutrient calculation software and based on known recipes of the meals.
II. To compare the energy, macronutrients, salt, and fiber contents of ready-to-eat meals sold in groceries and delivered by catering services in Hungary with the nutritional guidelines published by the World Health Organization according to gastronomic backgrounds. The nutritional information was obtained from the product label.
III. To determine if the nutritional and sensory characteristics of homemade meals are healthier and better than RTE meals where the nutrient content was determined by laboratory tests on the one hand and was derived from the label or calculated with nutrient calculation software where it was appropriate, on the other hand. The home-made meals were the same as the RTE ones, to the best of the knowledge of the kitchen professionals who prepared them.
IV. To evaluate chefs' perception on health and nutrition using a self-created questionnaire.
V. To evaluate the Hungarian population's beliefs and attitude regarding the healthiness and nutritional content of ready meals in the framework of a representative questionnaire survey.

3. MATERIALS AND METHODS

3.1. The types of meals examined and related definitions

Traditional meal: A meal was considered a “traditional meal” if all the ingredients and preparation methods in the recipe were mainly traditional as known to the people from the same nation.

Innovative meals: In other words, meals that use non-traditional ingredients and seasonings or incorporate modern kitchen techniques or machines are considered "innovative meals."

Ready-to-eat meal (RTE meal): A pre-prepared main course that can be reheated in its container for no more than 15 min and requires no additional ingredients Howard *et al.* (2012).

Main course: A meal that is consumed at lunch and represent a main meal to people from the same nation.

Single dose delivery service: The product, packaged in a sealed plastic tray with a label mainly containing the name, weight, and shelf life of the product, is delivered to the house by the company, and only heating is required before consumption.

Prepacked meals: prepacked meals refer to meals that are packaged and sold in a ready-to-eat form.

Non-prepacked meals: Non-prepacked meals are meals that are not packaged or processed, but rather made fresh, often from raw ingredients.

3.2. Reference values

Energy: The European Parliament and Council Regulation 1169/2011 establishes the daily reference intake for energy for adults at 8,400 kJ or 2,000 kcal. Main dishes are assessed based on 35% of this recommended energy intake, which equals 700 kcal (EU, 2018; Nutrition Advice Team, 2017; FAO, 2019; Ministerial Decree of Ministry of Human Resources, Hungary, 37/2014. [IV. 30.], 2014).

Macronutrients: According to WHO, these nutrients should account for 15-30% of energy intake for fat, less than 10% of energy intake for saturated fatty acids, 55-75% of energy intake for carbohydrates, less than 10% of energy intake for sugar, and 10-15% of energy intake for protein (WHO, 2003).

Sodium and fiber: Special indexes developed by Howard et al. (2012) were used to compare the sodium and fiber content in a meal. According to EU regulation 1169/2011, which sets reference values for energy (8.4 MJ) and salt/sodium (5 g/2 g), a sodium content of 0.2 g/MJ means that values above this do not meet the international sodium recommendation. For fiber, the European Food Safety Authority recommends a daily intake of 25 g and with an energy intake recommendation of 8.4 MJ, a value greater than 3 g/MJ must meet this recommendation.

3.3. Comparison of traditional and modern meals: Jordan and Hungary

In the comparison of traditional and modern meals in Jordan and Hungary a total of 40 Jordanian recipes were obtained from the online platform of Manal Alalem, a renowned Jordanian cook, while the Hungarian recipes (also 40 in total) were sourced from four books, including traditional cookbooks and a book with novel recipes.

The nutritional values of the selected meals were calculated for one serving using two software programs (ESHA Food Processor® Nutrition Analysis, and NutriComp DietCAD).

3.4.Examination of Hungarian ready-to-eat meals

Data on nutritional information for 177 prepackaged RTE meals from 15 different commercial brands were collected from grocery stores in Hungary in March 2020. The meals were packaged in plastic trays, paper boxes, glass containers, or metal tin cans and were labeled as whole foods. Additionally, nutritional information for 1017 non pre-packaged RTE meals delivered by seven leading food delivery companies in Hungary between March 1st, 2020, and May 31st, 2020, was obtained.

3.5. Examination of nutritional content and organoleptic characteristics of non-prepacked ready-to-eat and home-made meals

The meals were acquired on three separate occasions between August and October 2021.

The ten meals used in the study are:

- Fried pork ribs with sour cream, grated cheese, and potatoes with parsley (RS)
- African catfish fillet in fresh basil sauce, potato croquette (AH)
- Brasov stew (BAP)
- Broccoli layered with chicken, cheese, and eggs (CSTB)
- Grilled chicken breast, cream cheese sauce, jasmine rice (GCS)
- Meat casserole with cauliflower (HRK)
- Roasted chicken liver with boiled potatoes (CSM)
- Székely cabbage (SZK)
- Vasi steak with mashed potatoes and onions (VPHT)
- Beef stew with red wine and eggs barley (VM)

Sensory analysis was conducted by five trained panellists who assessed the meals for appearance, consistency, smell, and taste according to the Hungarian Standard MSZ ISO 6658:2018.

Nutritional analysis of the meals involved homogenizing one portion of each meal and analyzing the dry material, fatty acid composition, salt, and macronutrient contents. The macronutrient content was determined using AOAC established methods for fat (Soxhlet), protein (Dumas), and carbohydrate (total carbohydrate) analysis. Crude fat was measured using a semi-automatic system (SOXTHERM 2000, Gerhardt, Germany), crude protein was determined by analyzing total nitrogen by whole combustion of the sample under oxygen (Elementar, Rapid cube, Germany), and total carbohydrate was measured titrimetrically after a long acidic hydrolysis based on classical Schoorl method. For sugar content, a titrimetric Luff-Schoorl method was used without acidic hydrolysis. The salt content was determined using Mohr's method. The energy content was calculated based on the analytical results of macronutrients. Fatty acid analysis was conducted using gas chromatography.

3.6. Chefs' Perception of Nutrition and Health in Hungary

A questionnaire was developed to evaluate chefs' perception of nutrition and health. It was created by modifying and expanding previous surveys conducted by Johnson et al. (2002) and Vandana and Kusuma (2017), based on Palmer's and Leonto's (1995) survey. The questionnaire was distributed via Google Forms to 2,446 hospitality businesses in Hungary with permanent kitchens,

including restaurants, bistros, grill bars, and public catering services. The data collection period was between March 2021 and January 2022.

A total of 190 complete responses were received after excluding responses from consumers, waiters, salespeople, and consultants. The email addresses were collected using a systematic Google search method based on Hungary's regions and capital.

The questionnaire consists of two sections. The first section includes nine questions on demographic information, such as position, gender, age, qualification, work experience, establishment type, establishment location, consumers' nationality, and the respondent's age. The second section comprises 30 statements/questions aimed at assessing chefs' perceptions towards health and nutrition. This section is divided into four parts: perception on health (seven statements), perception on nutrition (five statements), perception on nutrition practices (10 statements), and perception on consumer concern (eight statements). Respondents were asked to use a 5-point Likert scale, with options ranging from '1' (strongly disagree) to '5' (strongly agree).

3.7.Consumers' belief and attitude regarding the healthiness of RTE meals in Hungary

A questionnaire was developed to assess Hungarian consumers' beliefs and attitudes towards ready-to-eat (RTE) meals. The questionnaire consists of 30 questions divided into two parts.

The first part comprises eight demographic questions, including gender, age, weight, height, qualification, income, location, and occupation. The second part of the questionnaire includes 22 questions aimed at evaluating consumers' beliefs and attitudes regarding the healthiness and consumption of RTE meals.

Data collection was conducted by ResearchCenter Ltd. in Budapest, Hungary, using their own panel and, to a lesser extent, a partner panel.

3.8. Statistical analysis

In this subchapter, various statistical methods were employed to analyze the data from the research. The comparison of traditional and modern meals in Jordan and Hungary utilized the Wilcoxon test to compare the percentage of energy per serving and macronutrient energy percentage in meals. The examination of Hungarian ready-to-eat meals involved the Wilcoxon test to compare nutrient contents and energy percentage, as well as the $\chi 2$ test to assess differences within the recommended nutrient range. For the examination of nutritional content and organoleptic characteristics of non-prepacked ready-to-eat and home-made meals, a multivariate analysis of variance (MANOVA) was used, along with descriptive analysis and independent samples t-test. The chefs' perception of nutrition and health in Hungary was analyzed using the Mann-Whitney U and Kruskal-Wallis tests, along with descriptive analysis. Finally, consumers' belief and attitude regarding the healthiness of RTE meals in Hungary were examined using descriptive analysis and cross tabulation. A significance level of $\alpha = 0.05$ was generally applied for these statistical tests.

4. RESULTS AND DISCUSSION

This section is divided into five parts. Each part will contain the research's results and discussion of each research done for the objectives mentioned in the objective part of the dissertation.

4.1. Nutritional value of traditional and modern meals: Jordan and Hungary

In the Jordanian meals, none of the meals met all the recommended nutrient values. The carbohydrate content was significantly lower than the lower end of the recommendation, while the sugar and saturated fatty acids content met the recommendation of less than 10% of energy. The protein content exceeded 15% of energy, and the fat content exceeded the upper limit of the recommendation. Jordanian meals also did not meet the recommendations for sodium and fiber. Similarly, in the Hungarian meals, none of the meals met the recommended nutritional guidelines. The energy content deviated significantly from the recommended value. The carbohydrate and sugar content were below the recommended lower limit, while the protein and fat content exceeded the upper limit. The median values for saturated fatty acids, fiber, and sodium also significantly differed from the recommendation. Overall, both Jordanian and Hungarian meals fell short of meeting the recommended nutrient values, indicating a need for improvement in aligning the meals with the recommended guidelines.

4.2.Nutritional content of prepacked RTE meals sold in groceries and non- prepacked RTE meals delivered by catering industry in Hungary

4.2.1. Nutrients in different types of prepacked ready-to-eat meals sold in groceries

In our study, we examined the nutrient composition of prepacked RTE sold in major supermarkets in Hungary. The meals were divided into two categories: traditional Hungarian and innovative.

The median energy content per serving was 432 kcal, ranging from 259 to 1009 kcal. The fat content per serving varied from 2.0 to 58.4 g, with a median of 18.0 g. Saturated fat content ranged from zero to 19.2 g, with a median of 6.8 g. Carbohydrate content per serving ranged from 5.3 to 93.1 g, while sugar content ranged from 0 to 56 g. Protein content per serving varied from 1.2 to 52.4 g, with a median of 46.5 g. Sodium content per serving ranged from 0 to 2.89 g/MJ, with medians of 8 g and 1.26 g/MJ, respectively.

In terms of energy, carbohydrate, and protein content per serving, the traditional Hungarian dishes had lower amounts compared to the innovative ones. However, the traditional dishes contained higher levels of fat and sodium. The differences in saturated fatty acid and sugar content were not statistically significant.

Figure 1 illustrates the energy percentage derived from the daily reference intake of 2000 kcal, energy derived from macronutrients, and sodium (g/MJ) across different types of ready-to-eat meals. Compared to the innovative dishes, the traditional Hungarian meals showed a reduction in energy, carbohydrates, and protein percentages. On the other hand, the creative meals had significantly lower energy derived from fat, saturated fatty acids, sugar, and sodium.

Overall, the study highlights the variations in nutrient composition among prepacked RTE meals in Hungarian supermarkets, with traditional Hungarian meals tending to have higher fat and sodium levels compared to innovative options.

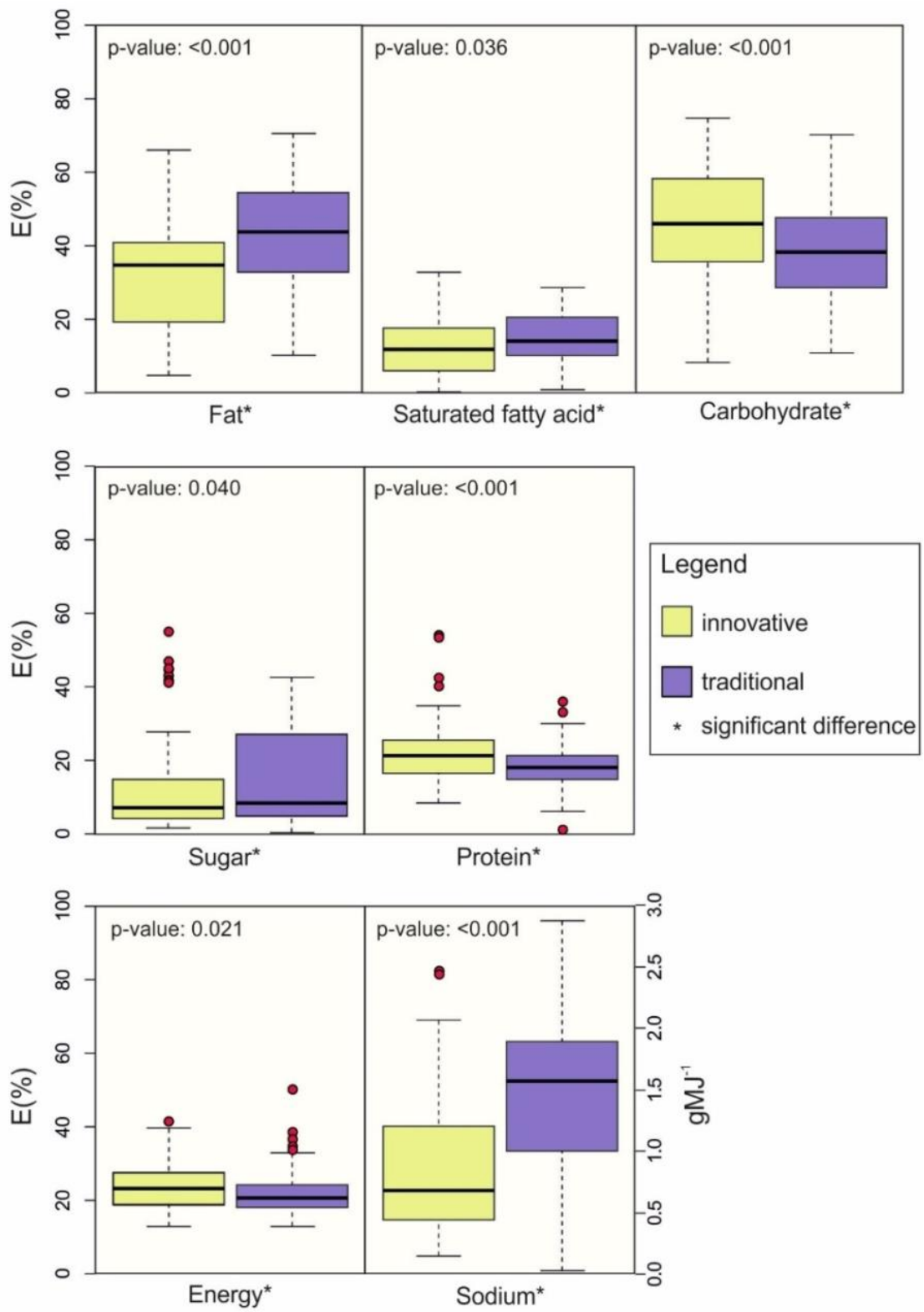

Figure 1 Boxplots of energy derived from daily reference intake (2000 kcal) and sodium (g/MJ) in ready-to-eat meals sold in leading supermarkets in Hungary

(In this context, energy refers to the percentage of energy derived from daily reference intake (2000 kcal). The energy derived from each macronutrient, including fat, saturated fatty acid, carbohydrate, sugar, and protein, is also represented. The sodium content of a single serving meal is indicated as g/MJ. Outliers are indicated by red dots. Statistical differences were calculated using the Wilcoxon-test, with $p<0.05$.)

4.2.2. Nutrients in the prepacked RTE meals sold in groceries referring to the recommendations

The $\chi 2$ tests in Table 1 indicate the significant differences between traditional and innovative RTE meals in meeting the recommendations for fat, carbohydrates, and protein. Innovative meals had a significantly higher proportion of fat and carbohydrates that complied with the recommendations. However, traditional RTE meals had a higher proportion of foods that met the recommendation for protein content.

Table 1 Results of $\chi 2$ tests conducted on the number of traditional and innovative meals that meet the recommendations

Nutrients	**Traditional**	**Innovative**	***p*-value**
	proportion of meals meet the recommendation, %		
Energy (% of 2000 kcal)	5.8	11.0	0.208
Fat (E%)	15.4	30.1	0.019
Saturated fatty acid (E%)	25.0	38.4	0.057
Carbohydrate (E%)	2.9	32.9	<0.001
Sugar (E%)	53.9	65.8	0.113
Protein (E%)	27.9	13.7	0.025
Sodium density (g/MJ)	0.98	1.45	1.000*

*χ^2 approximation may be not correct, because the expected counts within the recommendation are too small in the categories (<5). The Yates continuity correction was used.

None of the meals met the WHO nutrient intake goals for preventing diet-related diseases. The fat, saturated fatty acid, and protein intake goals were exceeded in the RTE meals, while the energy derived from carbohydrates was below the recommended level in both traditional and innovative meals. Only innovative meals met the recommended value for sugar intake. The protein content in both groups of RTE meals exceeded the recommended level.

4.2.3. Nutrients in different types of non-prepacked RTE meals delivered by food services

Figure 2 illustrates that traditional Hungarian RTE meals had significantly higher energy content, energy derived from fat, saturated fatty acid, and sodium content when compared to innovative meals, in terms of percentage of the daily recommended value of 2000 kcal. In contrast, innovative meals had significantly higher energy derived from carbohydrates, sugar, and protein. However, there was no significant difference in fiber content per energy unit between the two types of meals.

According to the results of the $\chi 2$ test presented in Table 2, there are notable dissimilarities between the conventional and modern RTE dishes in fulfilling the guidelines for energy, fat, carbohydrate, protein, and sodium. The innovative dishes exhibited a significantly greater ratio of meals that satisfied the recommendations for energy, fat, carbohydrate, and sodium, whereas the conventional RTE dishes had a higher proportion of meals that fulfilled the requirement for protein.

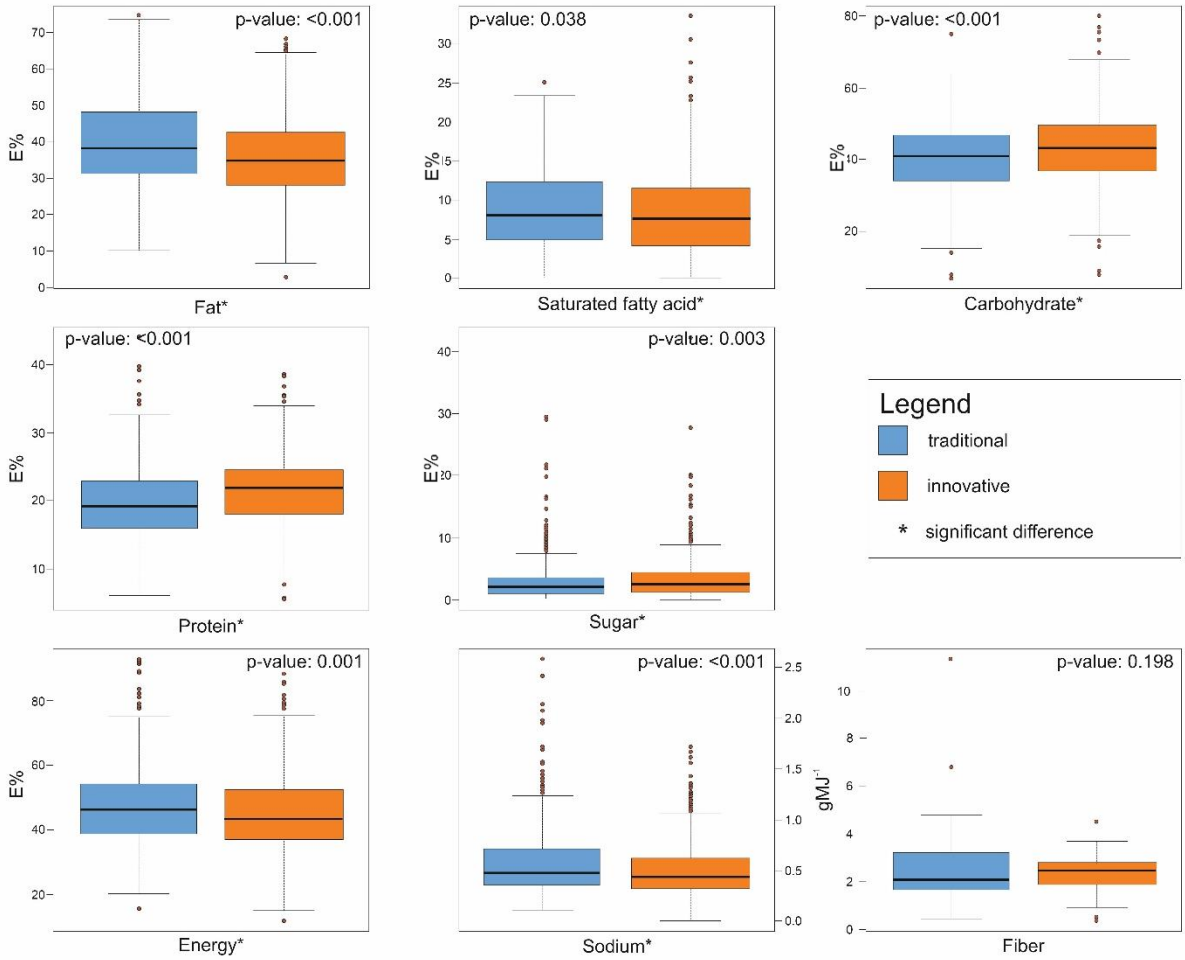

Figure 2 Boxplots of energy derived from daily reference intake (2000 kcal), sodium and fiber (g/MJ) of RTE meals delivered by food services in Hungary (traditional n= 477, for fiber n=48; innovative n=540, for fiber n=55)

(The daily reference intake (2000 kcal)-derived energy percentage is represented by the term "energy" in the lower left corner of this figure, whereas "fat," "saturated fatty acid," "carbohydrate," "sugar," and "protein" refer to the energy derived from the respective macronutrient. "Sodium" and "fiber" denote the sodium and fiber content of a single-serve meal expressed as g/MJ. The significant differences were calculated using the Wilcoxon test, with a significance level (α) of 0.05.)

Table 2 Results of χ^2 tests conducted on the proportion of the traditional and innovative meals that meet the recommendations (α=0.05)

Nutrients	**Traditional**	**Innovative**	***p*-value**
	proportion of meals meet the recommendation, %		
Energy (% of 2000 kcal)	23.3	29.3	0.015
Fat (E%)	20.5	27.8	0.004
Saturated fatty acid (E%)	63.3	67.8	0.067
Carbohydrate (E%)	6.1	9.3	0.029
Sugar (E%)	95.4	93.9	0.146
Protein (E%)	17.2	11.1	0.003
Sodium density (g/MJ)	2.3	5.4	0.006
Fiber density (g/MJ)	27.1	14.5	0.058

4.2.4. *Nutrients in the non-prepacked RTE meals delivered by food services referring to the recommendation*

In this study, the RTE meals examined were intended to substitute for one main course and were delivered to homes or workplaces by the company. The meals were packaged in sealed plastic trays and labelled with the product name, weight and shelf life. Heating the meals was the only required preparation before consumption. As a result, one serving size corresponded to the package size of the meals, which ranged from 250 g to 500 g (n=1017).

The median value of the total energy amount per serving of RTE meals was 900 kcal, but there was a wide variation between 236 to 1858 kcal. The quantity of fat per portion ranged from 2.0 to 131 g, with a median value of 36.3 g. For each serving, the amount of saturated fatty acids ranged from 0.0 to 41.6 g, with a median value of 7.8 g. The median values for carbohydrates, sugar, protein, sodium, and fiber per serving were 92.5 g, 5.2 g, 46.2 g, 1.7 g, and 7.6 g, respectively. However, the amount of each nutrient varied considerably, with the lowest and highest values being 12.0 and 253 g for carbohydrates, 0 and 68.3 g for sugar, 6.8 and 97.9 g for protein, 0 and 9.0 g for sodium, and 1.2 and 25.0 g for fiber (n=1017).

In this study, both traditional and innovative RTE meals were examined, and neither met the nutrient intake objectives established by the WHO to prevent diet-related diseases. The amount of energy, fat, and sodium expressed as g/MJ, as well as the percentage of daily reference intake derived from 2000 kcal, exceeded the recommended levels. Figure 3 demonstrates that the carbohydrate energy content of both meal types was below the recommended levels, whereas the protein energy content exceeded the recommendations. Only a small number of samples satisfied the fiber content requirement, while both meals met the recommendations for sugar and saturated fatty acid content, as depicted in Figure 4.

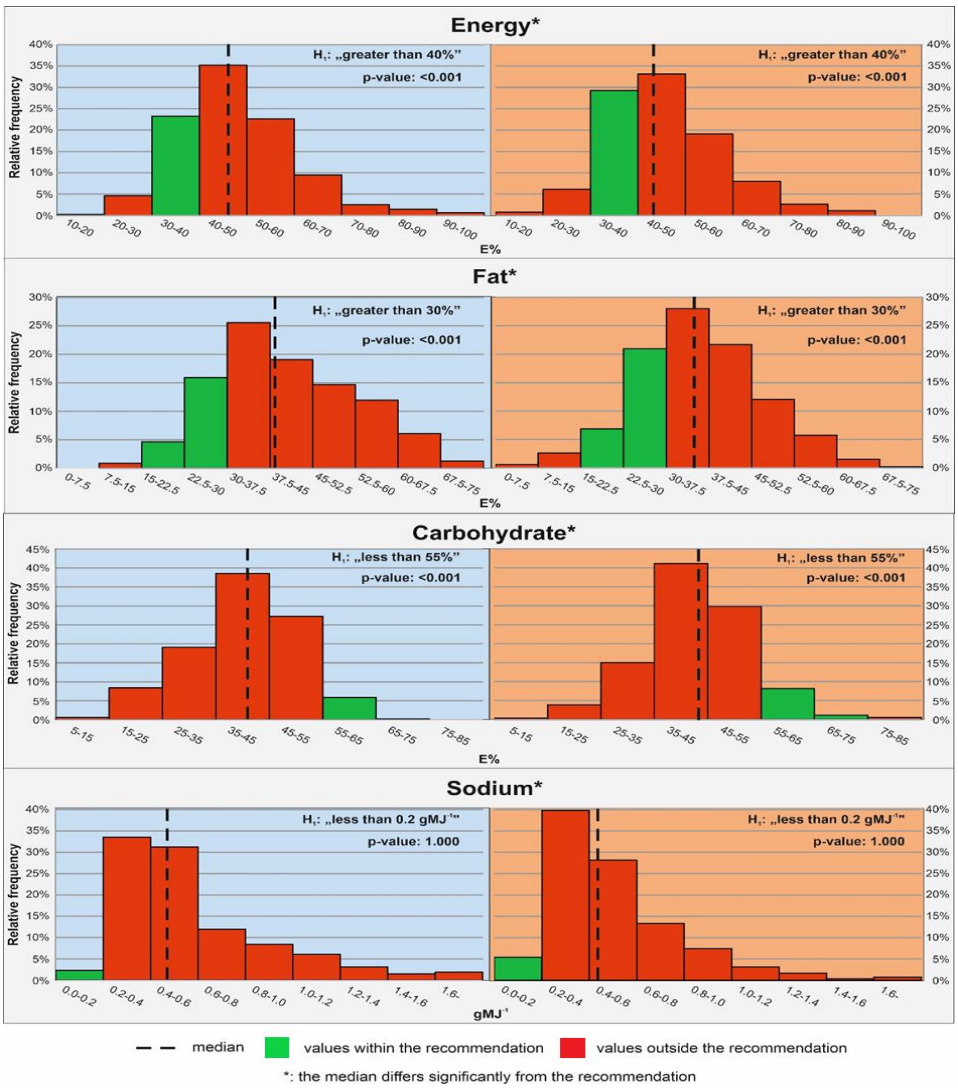

Figure 3 Histograms of the energy percentage derived from the daily reference intake (2000 kcal), energy% derived from fat and carbohydrate, and the sodium content (g/MJ) of two types of RTE meals: traditional (n=477, on the left with a blue background) and innovative (n=540, on the right with an orange background)

(Wilcoxon-test was used to compare the energy and nutrients' energy percentage of ready meals to recommendations at α=0.05. The nutrients in meals were compared to the WHO recommendation and to the Hungarian Ministerial Decree published in 2014; a 35% of the total daily intake of calories [2000 kcal]. The sodium recommendations were based on 8.4 MJ/day diet and recommended daily sodium intake of 2 g.)

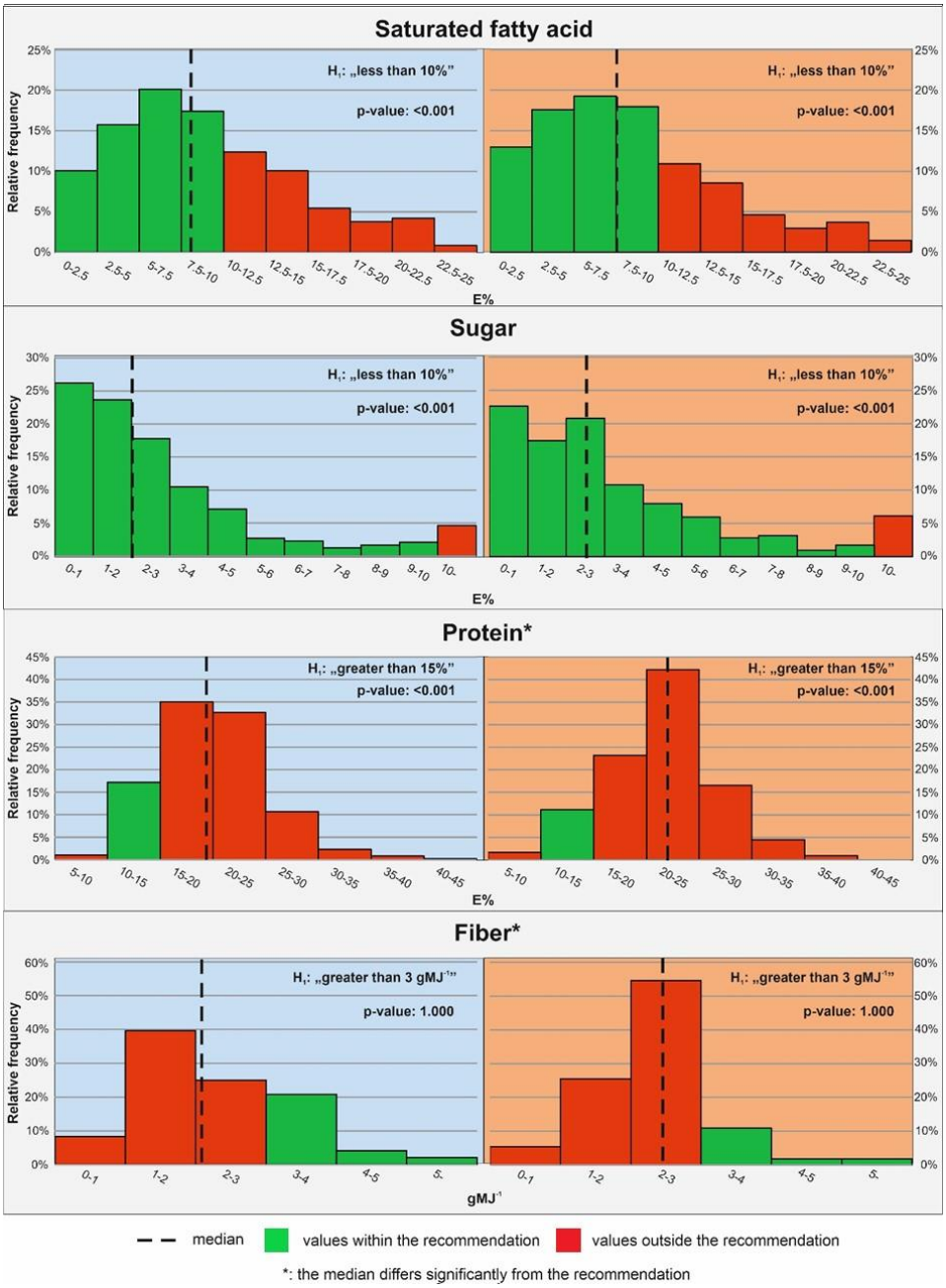

Figure 4 Histograms of the energy% percentage derived from saturated fatty acids, sugar and protein, and the fiber content (g/MJ) of two types of RTE meals: traditional (n=477, for fiber n=55, on the left with a blue background) and innovative (n=540, for fiber n=48, on the right with an orange background)

(Wilcoxon-test was used to compare nutrients' energy percentage of ready meals to recommendations at α=0.05. The meals were compared to the WHO recommendation. The fiber recommendation was based on 8.4 MJ/day diet and recommended daily fiber intake of 25 g.)

4.3. Nutritional content and organoleptic characteristics of non-prepacked ready-to-eat and home-made meals

4.3.1. Comparison of organoleptic characteristics of non-prepacked RTE and HM meals

Figure 5 displays that there was a significant difference between RTE and HM meals on the dependent variables at p <0.001. When considering the results for dependent variables separately, Figure 5 demonstrates significant differences in appearance, consistency, smell, and taste. The means of HM meals were higher than RTE meals in all dependent variables; appearance (4.82 vs.

3.94), consistency (4.63 vs. 3.54), smell (4.74 vs. 3.72), and taste (4.59 vs. 3.42). The t-test indicated that HM meals (M=18.79, SD=1.31) were significantly more acceptable than RTE meals (M=14.55, SD=2.86) according to the MSZ standard; p<0.001.

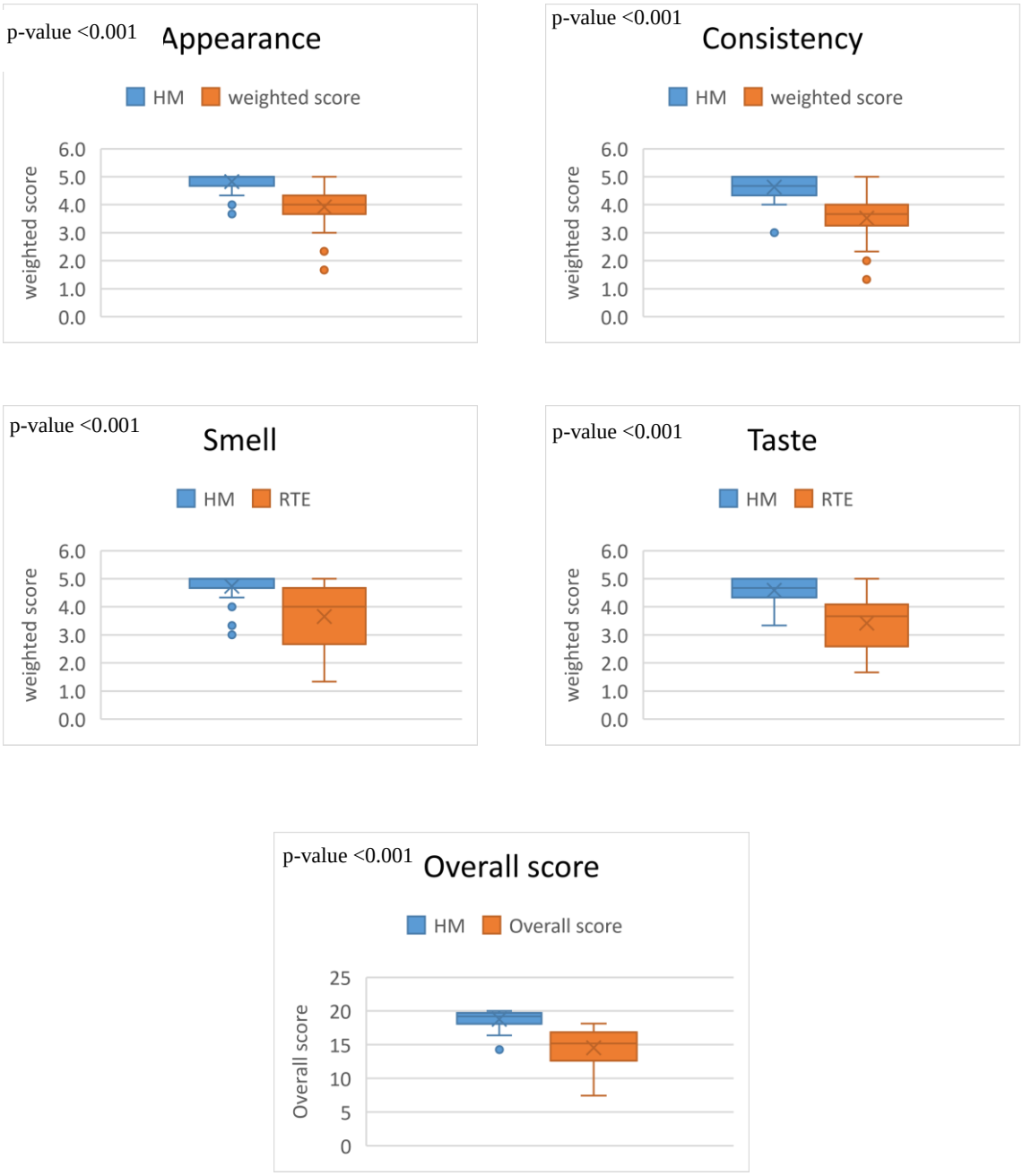

Figure 5 Comparing appearance, consistency, smell, and taste between RTE and HM meals based on the same recipes

4.3.2. Comparison of the nutritional content of RTE and HM meals

To investigate the difference between HM and RTE meals, a one-way multivariate analysis of variance was performed using eight dependent variables: weight, macronutrients (carbohydrates, sugars, fats, SFA, and proteins), sodium, and calories, with meal type being the independent variable. Results showed no significant difference between RTE and HM meals in terms of the combined dependent variables, F (8, 51) = 1.474, p = 0.190; Wilks' Lambda = 0.812.

4.3.3. Trans and saturated fatty acids content of non-prepacked RTE and HM meals

The presence of trans-fatty acids in RTE and HM meals has little significance. Elaidic acid is the primary trans-fatty acid and was not detected in all samples. Other trans-fatty acids found were C18:2 9t12t, C18:2 9c12t, C18:2 9t12c, and C18:1 11t (n-9) known as trans vaccenic acid.

Both RTE and HM meals contained palmitic and stearic acids as the main saturated fatty acids, with variations in their levels across different meals. The usage of sunflower oil in cooking contributed to the high content of palmitic acid in these meals.

4.3.4. Mono- and polyunsaturated fatty acids in non-prepacked RTE and HM meals

The results of the MANOVA analysis are presented in Table 3. To investigate the differences between fatty acid profiles of RTE and HM meals, a one-way between-groups multivariate analysis of variance was conducted. Seven dependent variables, including SFA, MUFA, PUFA, TFA, n-3 fatty acids, n-6 fatty acids, and n-6/n-3 ratio, were used. The independent variable was the type of meal. The combined dependent variables showed no statistically significant difference between RTE and HM meals. Moreover, Table 12 indicates the contents of SFAs, MUFA, PUFA, n-3, n-6, and n-6/n-3 ratio are similar in both RTE and HM meals.

Table 3 Fatty acid content comparison between RTE and HM meals

Fatty acids	**RTE meals (n=30)**	**HM meals (n=30)**	**p-value**
Saturated fatty acids (mg/100 g meal)	1525	1775	0.529
Monounsaturated fatty acids (mg/100 g meal)	1985	2382	0.347
Polyunsaturated fatty acids (mg/100 g meal)	2050	2184	0.101
Trans fatty acids (mg/100 g meal)	20.1	38.3	0.069
n-3 fatty acids (mg/100 g meal)	41.5	48.8	0.545
n-6 fatty acids (mg/100 g meal)	2002	2125	0.811
n-6/n-3 ratio	67.1	61.1	0.786

In general, both RTE and HM meals in Hungary contain an appropriate amount of SFA and TFA. Nevertheless, they contain a low amount of EPA, DHA and ALA. RTE meals contain less TFA than HM meals (difference is not significant), and are equal in EPA, DHA, and ALA.

4.3.5. *The accuracy of food labelling*

Table 4 shows the comparison of energy, macronutrient, and salt between the analytical and RTE meals' label's values with the analytical values' lower and upper confident intervals. There were significant differences between the value listed on the RTE meals' labels and the analytical values regarding weight, energy, carbohydrate, and fat content. The protein, sugar, saturated fatty acids, and salt content were not significantly different. The actual weight of the meals was less than the one listed on the label. The analytical values of energy, carbohydrate, and fat contents were less than the labelled ones.

Table 4 Comparison of the average energy, macronutrient and salt content between measured and labelled values in RTE meals

Variable	Analytical value (n=30) Lower CI 95%	Analytical value (n=30) Upper CI 95%	Analytical value's means (n=30)	Label values' means (n=10)	p-value
Weight (g/serving)	503	551	527	478	<0.05
Carbohydrate (g/serving)	38.7	53.3	46.0	71.2	<0.05
Sugar (g/serving)	5.51	6.79	6.15	4.72	0.057
Fat (g/serving)	24.2	31.8	28.0	40.3	<0.05
Saturated fatty acids (g/serving)	6.16	8.96	7.56	11.7	0.061
Protein (g/serving)	28.5	33.0	30.8	36.5	0.245
Salt (g/serving)	6.09	7.53	6.81	6.71	0.949
Energy (kcal/serving)	525	625	575	825	<0.05

In general, the labelling in the Hungarian catering industry is not precise. Food caterers need to implement additional food quality measurements, and relevant authorities must take more stringent action to meet EU regulation No. 1169/2011's mandatory nutritional labelling requirements.

4.4. Chefs' perception of nutrition and health in Hungary

The responses to our survey showed no significant differences related to nutrition in menu planning based on chefs' and culinary personnel backgrounds (i.e., gender, age, position, educational level, work experience, and type and location of establishment). However, managers and owners consider health more than chefs and cooks. Personnel with more than 15 years of experience consider health aspects more than those with less than 15 years. We can draw the idea that chefs and cooks in Hungary require more nutritional training.

4.5. Consumers' belief and attitude regarding the healthiness of RTE meals in Hungary

We had 1000 complete responses from Hungarian consumers. 23.74% of respondents never consumed RTE, 32.9% of them used to consume it but stopped. Thus, at the time of the survey, 56.8% of the respondents were not consumers of RTE. More than one third of the respondents (35.3%) have been consuming this type of food for a long time, and another 7.9% have recently added this type of convenience product to their diet. We included the 23.74% of consumers that never consumed RTE meals to understand why they don't choose to consume RTE meals.

Figure 6 shows the reasons why the consumers (who never consumed and who stopped consumed recently, totally 56,8%) refuse to consume RTE meals. Respondents could choose more than one reason. A total 1691 answers were recorded. The main reason to not consume RTE meals for the Hungarian consumers was that they like to prepare their own food (20% of 1691 answers), followed by the opinion that RTE meals are expensive (15%), and full of preservatives (12%), and according to only 1% of respondents, RTE portions are too large. It is no shock that consumers who chose not to consume RTE meals enjoy cooking.

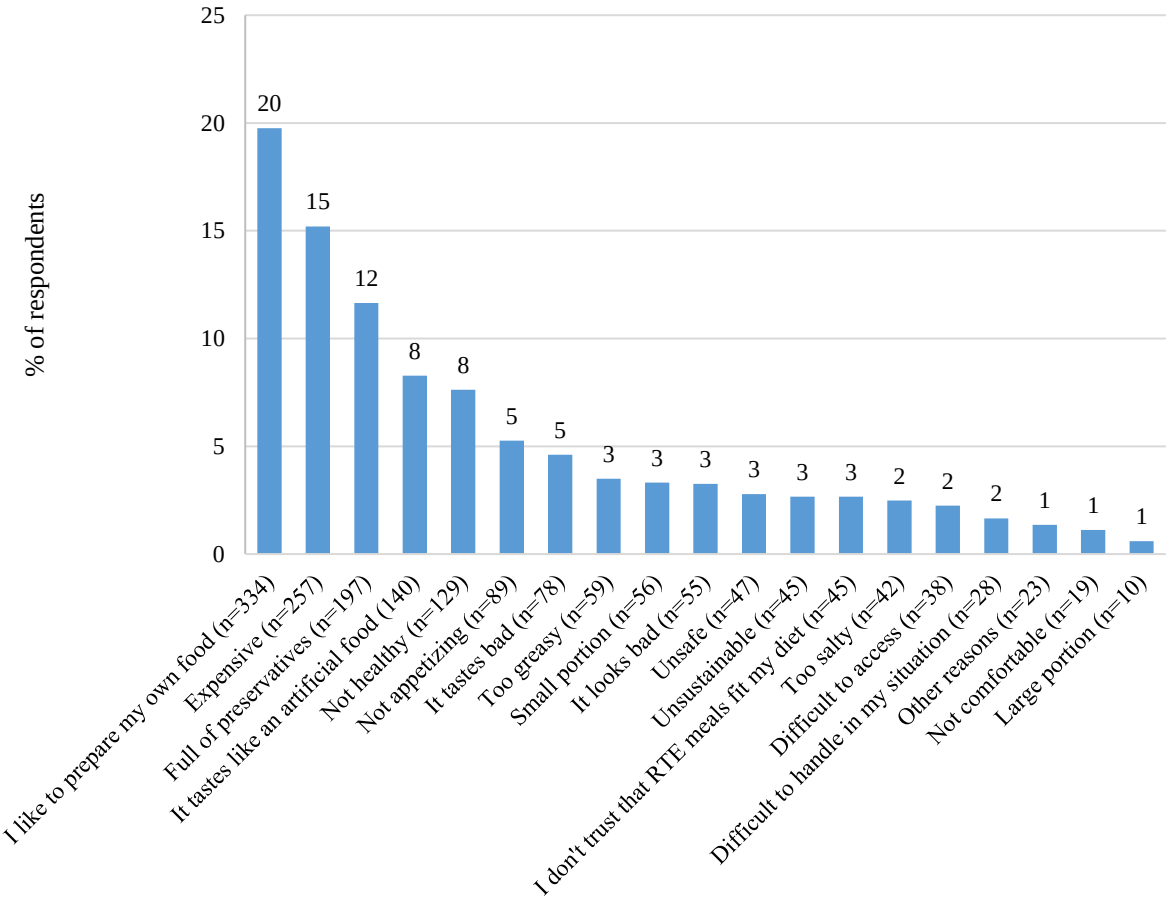

Figure 6 Reasons why respondents do not consume RTE meals (capita, percentage of total respondents)

Figure 7 shows where and when do Hungarian consumers consume RTE meals. 62% of consumers eat RTE meals when they are at home and 15% consume it when they are at the workplace. 23% eats RTE meals when they are either at home or the workplace. The RTE meals consumers that would eat the meals in any day count for 63%. 27% would eat it during the weekdays and 10% would eat it only in the weekends.

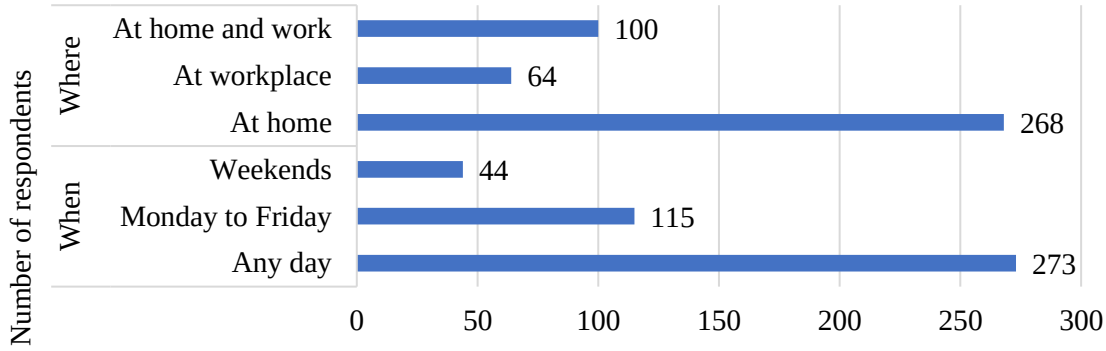

Figure 7 RTE consuming place and time (number of the respondents = 432)

The most common reasons included time-saving, quickly satisfying hunger, and wanting to spend time on other activities instead of cooking. The least motivating factors were inadequate kitchen equipment and the perceived health benefits of RTE meals.

Attitudes of consumers towards information on labels of ready-to-eat meals, such as ingredients and nutrients, are displayed in Figure 8. When purchasing RTE meals, 51% of the Hungarian consumers check the ingredients list, which affects their decision, while 20% check it without it influencing their choice, and 29% do not check it. In contrast, only 35% of Hungarian consumers check the nutritional label, which affects their decision, while 20% check it without it influencing their choice, and 45% do not check it.

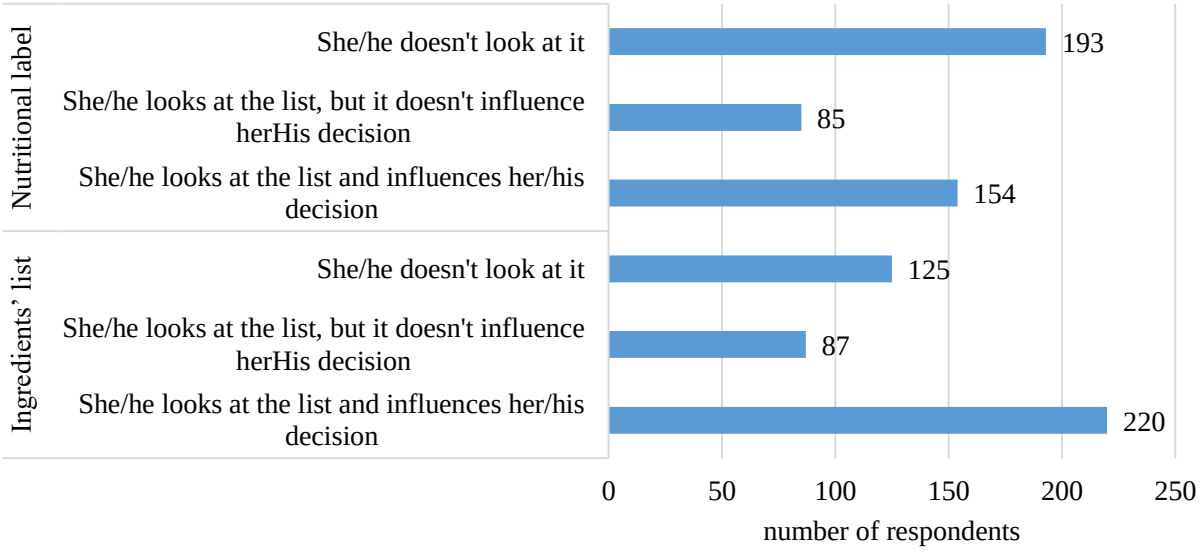

Figure 8 Number of RTE meal consumers in terms of how concerned they are with the ingredients and nutritional value of RTE meals

Furthermore, we investigated if there are any relation between RTE meals consumption, BMI, gender, age, education, and income. The consumption of RTE meals in the Hungarian consumers were independent from the income (Chi^2 (9) = 15.35; p=0.082) and BMI (Chi^2 (3) = 7.14; p=0.068). However, there is a relation between ready meals consumption, and gender (Chi^2 (1) = 7.19; p<0.001) and RTE meals consumption and age (Chi^2 (2) = 8.87; p<0.001. We found that Hungarian male consumes RTE meals more than the females according to the adjusted residuals

(|AdjRes|>2). Additionally, we found that Hungarian consumers between 35-49 years old consumer more RTE meals (|AdjRes|>2). Moreover, the consumption of RTE meals in the Hungarian consumers were dependent on education (Chi^2 (4) = 24.12; $p<0.001$).The Hungarian consumers who hold an elementary school education do not consume RTE meals more than consumers who is high school, university, college, or vocational school graduate and PhD or scientific degree holders (|AdjRes|>2). The Hungarian consumers who hold a university degree or college degree consume RTE meals more than other consumers with different educational backgrounds (|AdjRes|>2).

5. CONCLUSION AND RECOMMENDATIONS

Based on the data calculated from traditional recipes, neither Jordanian nor Hungarian traditional meals meet all the recommended nutritional requirements. Jordanian meals are low in carbohydrates and lack fiber, while having high protein, fat, and sodium content. Hungarian meals have lower carbohydrate and sugar content, but high protein, fat, and sodium content. Both cuisines require improvements in their nutritional value.

When comparing traditional and innovative ready-to-eat meals in Hungary, it was found that neither the prepacked nor the non-prepacked type fully met the WHO nutrient intake goals for preventing diet-related diseases. The traditional meals contained more energy, fat, saturated fatty acid, and sodium content, while the innovative meals had higher energy derived from carbohydrates, sugar, and protein. Both types of meals had more protein content than recommended, while only a small proportion met the recommended fiber intake. The innovative meals had a higher percentage of meals that met the recommendations for energy, fat, carbohydrate, and sodium, while the traditional meals had a higher percentage that met the recommendation for protein. It is evident that further improvements are required to make ready-to-eat meals in Hungary more nutritionally balanced, as per the findings of the study.

Regarding the study that compared the taste and nutrition of non-prepacked ready meals and homemade meals in Hungary. Homemade meals were more enjoyable, but there was no significant nutritional difference. Both met regulations for trans fats but lacked sufficient EPA, DHA, and alpha-linolenic acid. Ready meals had less trans fats, but otherwise, both types were similar. Labels on ready meals did not match nutritional content, highlighting a need for better food quality measurement and EU regulatory adherence.

Furthermore, based on our survey for chefs and consumers in Hungary; we can draw the idea that chefs and cooks in Hungary require more nutritional training. Also, the main reason why the consumers refuse to consume RTE meals was that they like to prepare their own food. On the other hands, the most common reasons for the Hungarian consumers to consume RTE meals are time-saving. In general, Hungarian consumers' views on the nutrition, healthfulness, and safety of RTE meals depend on whether they consume them or not.

Gastronomy, in general, plays an important role in determining the palatability and nutritional content of the foods consumed. More research should be done to determine the effect of gastronomy and cooking techniques on the micronutrient content of meals and their bioavailability. Furthermore, rather than viewing ready meals as a part of the problem, future research should focus on strategies to improve them and include them as a solution to combat non-communicable disease.

6. NEW SCIENTIFIC RESULTS

This research represents the first comprehensive investigation of its kind conducted in Hungary, focusing on the nutritional content of mixed dishes, as well as RTE meals, in comparison to nutritional recommendations within the context of gastronomy. It is also the first study to analyze the nutritional composition of RTE meals in a laboratory setting and compare them with homemade meals, while simultaneously assessing their organoleptic properties. Furthermore, this research pioneers the examination of chefs' and culinary personnel's awareness and nutritional knowledge, recognizing their crucial role in menu design and its impact on public health. Additionally, this study breaks new ground by exploring Hungarian consumers' attitudes and beliefs towards RTE meals, shedding light on an important aspect of their dietary choices. Overall, this research represents a pioneering effort in Hungary to address the multifaceted aspects of nutritional gastronomy and its implications for public health. The new scientific results of each research in this thesis are showing below:

I. Nutritional profile of traditional and modern meals

Our findings revealed that no Jordanian or Hungarian meals met all nutritional recommendations. Jordanian meals have significantly lower carbohydrate content, while protein and fat content exceed recommendations. Hungarian meals deviate from recommendations in the same way, with lower carbohydrate and sugar ratios and higher protein and fat content.

II. Nutritional evaluation of ready-to-eat meals

We found that none of the evaluated 177 prepacked ready-to-eat (RTE) meals (104 traditional and 73 innovative) met the nutrient intake goals recommended by the World Health Organization (WHO) for preventing diet-related diseases. The RTE meals had higher fat, saturated fatty acids, and protein content and lower carbohydrate content than the recommended value. There were significant differences between the traditional and innovative RTE meals. The innovative meals had a higher proportion of fat and carbohydrates that complied with the recommendations, while the traditional RTE meals had a higher proportion of foods that met the recommendation for protein content.

III. Comparison of homemade and RTE meals

When determining the nutritional and sensory characteristics of Hungarian homemade and RTE meals, we found that homemade meals scored significantly higher than RTE meals. While the difference in nutritional content between the two meals was not significant. Both homemade and RTE meals have appropriate levels of saturated and trans fatty acids but low levels of essential fatty acids.

IV. Chefs' perceptions of health and nutrition

Our survey results revealed no significant differences in nutrition in menu planning based on the backgrounds of chefs and culinary personnel (i.e., gender, age, position, educational level, work experience, and type and location of establishment). Managers and owners, on the other hand, prioritize health over chefs and cooks. Additional nutritional training for chefs and cooks in Hungary would be beneficial.

V. Hungarian consumers' beliefs and attitudes:

Over half of the 1000 respondents said they don't eat RTE meals because they prefer homemade food and are concerned about the cost and preservatives. In comparison to homemade and restaurant meals, non-consumers believe RTE meals are less healthy, contain harmful ingredients, and are less safe. More than one-third of respondents have been eating this type of food for a long time, and the most common reasons for doing so are time savings, quickly satisfying hunger, and wanting to spend time doing other things rather than cooking.

7. PUBLICATIONS RELATED TO THE SUBJECT OF THE THESIS

Journal articles publications

AlOudat, M., Papp, A., Magyar, N., Simon Sarkadi, L., Lugasi, A. (2020). Nutritional value of traditional and modern meals: Jordan and Hungary, Acta Alimentaria, 49(4), 491-497. doi: https://doi.org/10.1556/066.2020.49.4.15 (IF: 0,61; citation:2)

AlOudat, M., Magyar, N., Simon Sarkadi, L., Lugasi, A. (2021). Nutritional content of ready-to-eat meals sold in groceries in Hungary. International Journal of Gastronomy and Food Science, 24, 100318. doi: https://doi.org/10.1016/j.ijgfs.2021.100318 (IF: 3,194; citation: 12)

AlOudat, M., Magyar, N., Simon Sarkadi, L., Shaikh, A.M., Lugasi, A. (2022). Nutrient content of single-dose ready-to-eat meals delivered by catering industry in Hungary, Journal of Culinary Science Technology, doi: https://doi.org/10.1080/15428052.2022.2091071 (IF: 1,28)

Conference publications

AlOudat M., Papp, A., Lugasi, A., Magyar, N., Simon Sarkadi L. (2019). Nutritional analysis of traditional meals: Jordan and Hungary. In: Fodor, Marietta; Bodor, Péter (eds.) SZIENtific meeting for young researchers, Gödöllő, Hungary, Szent István University, pp. 13-19. 2019.

AlOudat, M., Magyar, N., Simon Sarkadi, L., Lugasi, A. (2020). Nutritional content of ready-to-eat meals sold in groceries in Hungary. Scientific Meeting of Young Researchers, Szent István University Budapest, 7th December 2020, ISBN 978-963-269-937-0, pp. 57-65.

Conferences

AlOudat M., Papp A., Lugasi A., Sarkadi L: Application of nutritional analysis software for comparison of nutritional value of traditional meals: Jordan and Hungary. XLIV. Congress of the Hungarian Society of Nutrition, Székesfehérvár 3-5 October 2019.

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Lugasi A., **AlOudat M.**, Magyar N., Sarkadi L.: Kiskereskedelmi forgalomban elérhető, egyadagos készételek tápanyagösszetételének elemzése. (Nutrional analyses of single dose ready-to-eat meals sold in groceries). Hungarian Academy of Sciences, 381. Scientific Colloquium of Food Science Scientific Committee, Budapest, 26th February 2021.

AlOudat, M., Simon Sarkadi L., Lugasi, A.: Chef's perception on nutrition and health. 18th Wellmann International Scientific Conference, online, 13th May 2021.

AlOudat M., Magyar N, Simon Sarkadi L., Lugasi A.: Nutrient content of single-dose ready meals produced and offered by catering industry. Scientific Meeting of the Hungarian Society of Nutrition, 3rd September 2021.

Lugasi A., Magyar N., Simonné Sarkadi L., **AlOudat M.**: Egyadagos ételkiszállító cégek ételeinek táplálkozási értékei. (Nutritional values of food from single-serve food delivery companies), HUNGALIMENTARIA, 9-10 November 2021.

M. AlOudat, L. Simon Sarkadi, H. Hidvégi, A. Balog-Sipos Szőcze, A. Lugasi: Comparison of organoleptic characteristics of ready-to-eat and home-cooked meals based on the same recipes. 4th FoodConf, Budapest, 9-10. June 2022.

AlOudat M., Sarkadi Simon L., Lenkovics B., Lugasi A.: The reliability of single-dose ready-to-eat meal labelling provided by the Hungarian catering industry. XLV. Congress of the Hungarian Society of Nutrition, Szeged, 20-22. October 2022.

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