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Social responsibility in reducing food losses and waste in the Slovak Republic: the role of policies – the responsibility of all

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ABSTRACT

The study aimed to point out the calls of the European Commission to the social responsibility of the solution of food losses and waste, to evaluate the current state of the researched issues in the Slovak Republic, to point out the trends, and propose measures to improve the situation of the food losses and waste on the poultry meat market in the Slovak Republic. The scientific hypotheses were established. A questionnaire survey was used to obtain primary data. The research object was households and agricultural enterprises of broiler chicken farming (poultry farms) in the Slovak Republic. Data from questionnaires completed by households and poultry farms were examined and processed by the sorting method. Cumulative totals, intervals, and percentage ranges were calculated in each response class. The obtained data for individual objects of research were processed by sorting using Microsoft Word tables – Excel, Office 2016. The chi-square test ($\chi 2$ test) with a contingency table according to the procedure of Social Science Statistics was chosen for hypothesis testing. The SAS program was used for statistical evaluation of the results and answers of the respondents from the questionnaires. The research shows that food losses in Slovak households were up to 40% and on poultry farms at 6.8%. Mould and rot were the most common causes of food degradation. Mortality during breed has been recorded as a cause of food waste in poultry farms. A statistically significant difference ($p \leq 0.001$) was found in the quantity of food losses between gross household income per family member and month. Statistically, no significant difference ($p > 0.05$) was found between the numbers of family members. The proposals were recommended to improve the solution of reducing food losses and food waste in households and poultry farms. Based on the application of a practical approach of households and poultry farms to reduce food losses and support innovative solutions, it is possible to achieve gentle practices in ensuring the security of nutrition, food production, social and economic sustainability as well as environmental protection in the Slovak Republic.

Keywords: food loss and waste, cause of origin, household behaviour, poultry farm, innovative approach

INTRODUCTION

Society's approach to food losses and food waste

Food waste is an unsustainable system of food production and consumption. Food and Agriculture Organization of the United Nations drew attention in 2013 to food waste, which is currently facing an environmental, economic, and social problem **[1]**. Approximately 1.3 billion tonnes of foods are globally degraded or end up as waste, representing a significant share of total food production **[2]**. The United Nations has also included food waste in one of its 17 Sustainable Development Goals (SDGs). Objective 12.3 focuses explicitly on reducing them and the whole production and supply chain. The aim is to halve global food waste per capita by 2030 **[3]**. The European Commission has recognized food waste as a priority area of the European Union's circular economy action plan **[4]**, which aims at a common approach to measuring food waste through appropriate indicators, promoting commitment, knowledge acquisition, and taking over best practices as well as improving legislative measures **[5]**. The European Union's announced strategy for an integrated farm-to-table system means focusing on all stages of the food chain, including food waste **[6]**. The adopted strategy aims to demonstrate how food waste can be transformed into valuable resources and how to create innovations and incentives to reduce it by 50% of its total

weight by 2030 and contribute to the transition to a circular economy **[7]**. The value of food waste, which can be avoided, is estimated based on research in several European countries and ranges between 3.2 and 6.1 €.kg^{-1}. In addition, the European Commission's Joint Research Center (JRC) has proposed a quantification procedure to prevent food waste and reduce environmental impact and economic savings **[8]**. Constructive discussions in academia on food losses from an economic and environmental perspective are taking place in academia. Researchers are also working on macroeconomic strategies that are useful in addressing this issue **[9], [10]**. Researchers are far from reaching a consensus on some topics in discussions on nutrition strategies. Most solutions to food losses are in studies focused on quantity and its impact on the environment **[11]**. Input-output analyses **[12]** are often used for these studies, especially a life cycle assessment **[13]**. These interdisciplinary efforts increasingly point to the complexity of dealing with food waste **[14]**. Households are identified as the sector with the characteristics that contribute most to food waste. Many studies indicate that the food waste of households can be avoided. Estimates suggest that 50 – 60% of losses and waste in the food supply chain across the European Union are generated by households and retails **[15]**, **[16]**. The European Fusions project states that about 60% of the waste generated by consumers (corresponding to 32% of all food waste) is an avoidable waste **[17]**. Estimates of unnecessary food waste from total household food waste vary from country to country **[18]**. The generation of food waste in households cannot be viewed in isolation from the other stages of the food chain, i.e. from the production phase to the consumption phase. Household food waste can also result from measures taken further down the food chain, such as misunderstood date labels, sealable packaging, and marketing strategies such as bulk packaging and special offers **[19]**.

In connection with the above, our research aimed to point out the European Commission's calls for social responsibility to address food losses and waste, evaluate the current state of researched issues, point out trends and propose measures to improve the situation of food losses and waste in the chicken meat market in the Slovak republic.

Scientific Hypothesis

Established scientific hypotheses – households and food waste

The number of members in the household affects the generation of food waste.

The age of household members affects food waste generation.

The income amount of household members affects the generation of food waste.

The amount of household expenditures on the purchase of chicken meat contributes to food waste.

Established scientific hypotheses – poultry farms and food losses

The poultry farm size affects the generation of food losses.

MATERIAL AND METHODOLOGY

Samples

A questionnaire survey was used to obtain primary data. The research object was households, and primary poultry farms focused on breeding broiler chickens in the Slovak Republic.

Instruments

Questionnaire survey.

Laboratory Methods

A questionnaire survey, the method of questioning, was used to solve research tasks. Our evaluation material was questionnaires and the respondents' answers to the questionnaire. The questionnaire contained 14 questions, to which the respondents answered numerically, verbally, or by supplementing the answers. The questions were open to respondents.

Description of the Experiment

Sample preparation: The sorting method examined and processed data from questionnaires completed by households and poultry farms. Cumulative totals, interval, and percentage range in the individual response classes.

Number of samples analyzed: Respondents from the addressed households returned 255 completed questionnaires, representing a 56% return of the questionnaires. The Slovak households and poultry farms survey took place from April 2021 to January 2022. Two companies completed the questionnaire intended for poultry farms for 15 fattening periods, which have a capacity of 500 thousand pcs of broiler chickens and 20 thousand pcs of broiler chickens for the fattening period.

Design of the experiment: Household research was focused on finding access to food losses and identifying foods in their households that are subject to losses. 2 household research factors are important for household research objects, namely the number of household members, while for the answer more members or fewer members the average number of household members was a clue to the answer 2.94 according to the Statistical

Office of the Slovak Republic from 2019 **[20]**. The second factor is income, while for the answer more income or less income was a clue to the answer the average income of € 577.50 per person and month, which results from the income of € 6,930 per person and year according to the Statistical Office of the Slovak Republic from 2019 **[20]**. Research in the poultry farms was focused on identifying the root causes of food losses with the possibility of addressing effective measures to reduce them.

Statistical Analysis

The data obtained from the questionnaires for individual objects were examined and processed by sorting using Microsoft Word tables – Excel, Office 2016. Cumulative totals, interval a percentage range. The SAS package, version 8.2, was used to statistically evaluate the results between household members and food waste and between total household income and food waste. Statistical evaluation of the results was performed based on descriptive characteristics by groups according to the values of a certain quantity ($\bar{x}$ – arithmetic mean, SD – standard deviation) and t-test for statistical significance of the difference between the groups.

The Chi-square test ($\chi 2$ test) with a contingency table was chosen to test the hypotheses. This test is suitable for comparing quantitative quantities. It is used to determine whether the abundances in the individual categories are distributed randomly, naturally, or whether a certain stimulus influenced the distribution of abundances in the individual categories. Based on this test, the frequency of occurrence is tested, and the dependence between the variables is determined. The Chi-square value of the test is compared with the theoretical Chi-square distribution to determine the probability of obtaining a random value. This probability represents the value of significance. The frequencies are significantly different if the significance value is lower than the significance level. In the calculation, we set *p*-value $\alpha = 0.05$. We tested the hypotheses in the same way: we determined a dependent and an independent variable. We have formulated hypotheses (H_0 - there is no statistically significant connection, H_A - there is a statistically significant connection). Reporting the Chi-square test results included the result of the statistical evaluation with Yates correction and the achieved *p*-value of statistical significance. We performed the calculations according to a freely accessible procedure published on the Social Science Statistics website.

We established the conclusions of the findings:

a) if the result of $\chi 2$ is $p \leq 0.05$, hypothesis H_0 was rejected, and hypothesis H_A was accepted,

b) if the $\chi 2$table >0.05, hypothesis H_0 was accepted, and hypothesis H_a was rejected.

By processing and evaluating the obtained research results, food losses and the main causes of their generation in the investigated objects were identified and characterized.

RESULTS AND DISCUSSION

Food losses and waste in households and poultry farms, causes of their generation

We used the Chi-square test to test the established hypothesis that the number of members in the household affects the generation of food waste. Contingency Table 1 provides information on the observed cell totals (expected cell totals) and the statistical evaluation according to the Chi-square test for each cell.

Table 1 Contingency table testing the hypothesis of the influence of the number of household members on the creation of food waste.

Number of members in the household	The number affects members	The number of members does not affect	Boundary row totals
More than 2.94	143 (127.5) [1.88]	112 (127.5) [1.88]	255
Less than 2.94	112 (127.5) [1.88]	143 (127.5) [1.88]	255
Boundary sums of columns	255	255	510 (total sum)

Source: Own research.

According to the chi-square test with Yates correction, the result of the statistical evaluation is 7.0588, and the *p*-value is 0.007888. A statistically significant dependence of $p \leq 0.05$ exists between the number of household members and food waste, i.e. food waste arises from a dependent variable.

Machate's [24] study shows a positive but weak correlation between family size and the amount of food waste generation per household. The results confirm the previous findings **[21]**, **[22]**, **[23]**.

We used the Chi-square test to test the established hypothesis that the age of household members affects food waste generation. Contingency Table 2 provides information on the observed cell counts (expected cell counts) and statistical evaluation according to the Chi-square test for each cell.

Table 2 Contingency table testing the hypothesis of the effect of age of household members on food waste.

Age in years	Age affects	Age does not affect	Boundary row totals
Up to 20	4 (51.00) [43.31]	251 (204.00) [10.83]	255
20 - 35	80 (51.00) [16.49]	175 (204.00) [4.12]	255
36 - 49	80 (51.00) [16.49]	175 (204.00) [4.12]	255
50 - 65	63 (51.00) [2.82]	192 (204.00) [0.71]	255
Over 65	28 (51.00) [10.37]	227 (204.00) [2.59]	255
Boundary sums of columns	255	1020	1275 (total sum)

Source: Own research.

The statistical evaluation results according to the Chi-square test are 111.8627. Value $p \leq 0.00001$. There is a statistically significant dependence between age and food waste at $p \leq 0.05$, i.e. food waste arises from a dependent variable.

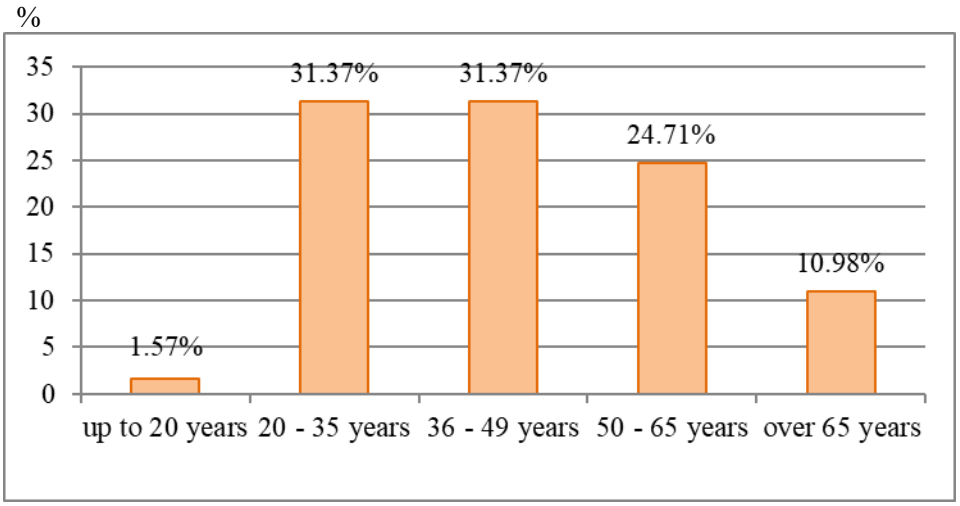

Figure 1 Involvement of household respondents to research by age. Source: Own research.

The total number of involved household respondents by age category in the survey was 255 (Figure 1). The most significant proportion were household respondents of the specified age category 20 - 35 years, i.e. 80 (31.37%) and 80 (31.37%) in the age group 36 - 49. This was followed by the age category of respondents of the household 50 - 65 years in 63 (24.71%). Respondents over 65 accounted for 10.98%, i.e. 28, and the least respondents participated in the research of the age group up to 20 years, only 4 (1.57%). It is also known from other research carried out in this area that respondents over the age of 20 to 35 are the most involved in similar research. An important category in assessing food waste is young people who, unlike seniors, have several characteristics that affect their food waste behaviour, such as education, lifestyle, shopping habits, and eating and storing food (especially when studying or working away from home). The results confirm an appositive and strong correlation between age and amount of food waste generation at a regression coefficient of 0.7 **[24]**.

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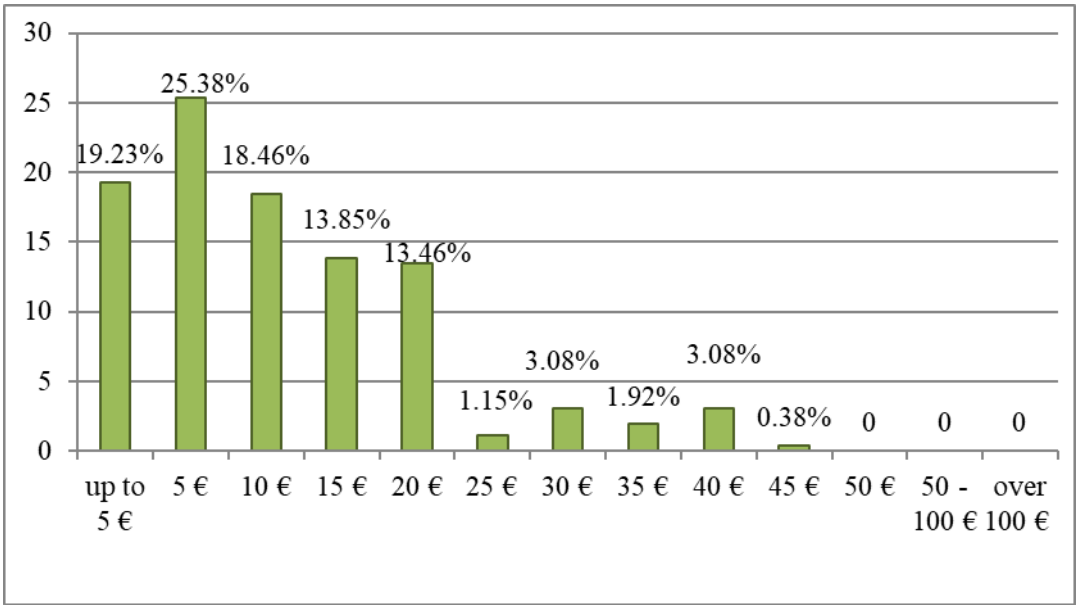

Figure 2 Household budget expenditure related to food waste per member and month in €.
Source: Own research.

Two hundred fifty-five household respondents answered the amount of budget expenditure per household member and month (Figure 2). When asked about household budget expenditure related to food waste and throwing food into the trashcan. Respondents indicated budget expenditures related to food losses in their household per member and month at most 66 (25.88%) at € 5, followed by food waste up to € 5 marked by 50 respondents (19.61%) and 48 household respondents (18.82%) food waste of € 10. Respondents reported food losses at almost the same level as € 15 and € 20, i.e. 36 (14.12%) and 34 (13.33%). Other respondents described food waste as higher but lower. For € 30 and € 40 of budget expenditures from the budget related to food waste per 1 member and month in €, respondents also indicated 7 (2.75%) and an even lower number of respondents, 4 (1.57%) indicated expenditures related to food waste of € 35 and 2 respondents (0.78%) of € 25 per member and month. The highest amount of household expenditures from the budget related to food waste per 1 member and month was given by one respondent (0.39%). Other amounts mentioned above of household expenditures from the budget pertaining to food waste per 1 member and month were not indicated by any respondents in the questionnaire. If we conducted research to address household budget expenditures related to food waste per member and month on these days after January 2022, the results would be different, higher as food prices have risen.

Tables 3 and Table 4 show a statistical evaluation of the impact of the number of members and the amount of income on household budget expenditures related to food waste per 1 household member and month. We found (Table 3) the average value of expenditures per 1 member and month in € from the household budget related to food losses € 11.37 with the number of household members more than 2.94 and € 12.78 with the number of household members less than 2.94. The difference in budget expenditures related to food waste per member and month between households with more than 2.94 members and households with less than 2.94 members was not statistically significant (p >0.05).

Table 3 Statistical evaluation of expenditure per member and month in **€** from the household budget related to food waste among the number of members in the household.

Number of members in the household	n	$\bar{x} \pm$ SD	t-test
More than 2.94	143	11.37 ±9.08	
Less than 2.94	112	12.78 ±9.55	0.2366

Note: n - multiciplity, $\bar{x}$ - mean, SD - standard deviation, 0.2366 - p value of the t-test (p >0.05), 1.1865^{-}) - a statistically significant difference. Source: Own research.

However, evidence from a 2019 survey showed that households the one adult and minor members could not afford lunch to satiety every other day. Up to one-third of the respondents involved in the research indicated this situation. On the other hand, households with two adults and one or two children are the least affected by this situation, which means that only about 6% of households with several members cannot afford lunch the next day **[25]**.

We used the Chi-square test to test the established hypothesis that the income amount of household members affects the generation of food waste. Contingency Table 4 provides information on the observed cell counts (expected cell counts) and the statistical evaluation according to the Chi-square test for each cell.

Table 4 Contingency table testing the hypothesis of the impact of members' income amount on food waste generation.

Income of members in the household	The number affects members	The number of members does not affect	Boundary row totals
More than 577.5 €	189 (127.5) [29.66]	66 (127.5) [29.66]	255
Less than 577.5 €	66 (127.5) [29.66]	189 (127.5) [29.66]	255
Boundary sums of columns	255	255	510 (total sum)

Source: Own research.

According to the Chi-square test, the statistical evaluation results are 118,6588 and $p \leq 0.00001$. There is a statistically significant dependence between household income and food losses at $p \leq 0.05$, i.e. food waste arises from a dependent variable.

We found (Table 5) the average value of household expenditures per 1 member and month of € 13.08 from the household budget related to food waste at the income of more than € 577.50 per member and month. If the household income was less than € 577.50 per 1 member and month, the average value of expenditures in such a household per 1 member and month from the household budget related to food waste was lower, € 6.89. The difference in budget expenditures related to food waste per member and month between households with more than € 577.50 and households with less than € 577.50 per member and month was statistically significant ($p < 0.001$).

Table 5 Statistical evaluation of expenditure per member and month in € from the household budget related to food waste between income per member and month in the household.

Household income	n	$\bar{x} \pm SD$	t-test
More than 577.50 €	189	13.08 ± 8.79	
Less than 577.50 €	66	6.89 ± 4.73	0.001

Note: n - multiciplity, $\bar{x}$ - mean, SD - standard deviation, 0.001 - p-value of t-testu ($p \leq 0.001$, 4.5177^{+++}) - a statistical significant difference.

Within the European Union, households in Slovakia generate less food waste than households in the other Member States. According to statistics, most per capita food ends in the Netherlands' trashcan. Food waste is the least generated in Greece, Malta, but also in the Czech Republic. The value of avoidable food waste is estimated based on research carried out in several European countries in 2020 and ranges between 3.2 and 6.1 €.kg^{-1} **[25]**. The complexities of food waste generation in its entirety are a subject of the social and economic profile of the generator. Evidence from Gustavsson et al. **[26]**, one of the leading global authors in food loss management, shows that food waste generation increases proportionally with the levels of development. As a result, developed countries generate more food waste than their developing counterparts **[24]**.

Respondents mentioned the foods that represent the biggest waste in their household, which are the most critical, and at the same time stated the percentage of their waste. This means which foods are most critical in their household. Respondents identified fruits, vegetables, dairy products, meat products, prepared food, pastries, bread, milk, and meat as the most critical foods. The enormous waste reported by household respondents with a maximum percentage of 40% of all food waste is fruit, vegetables, pastries, meat products for temporary storage, dairy products, especially cheese, yoghurt, cream, and prepared food. Household foodstuffs were most often degraded and damaged by fibrous microscopic fungi (mould), rot, fermentation, drying, and hardening (change in sensory properties), expiration date, large volume or quantity of prepared food - uneaten residue discarded or inedible, long storage time and ageing in stocks. Respondents in the questionnaire stated deterioration and damage of several types of foodstuffs.

Studies **[26]** and **[27]** argue that consumers in developed countries buy more food than they need. They support that high household income is proportional to increased food waste production. In contrast, consumers in

developing countries buy smaller quantities of food with each purchase. This process affects the way food is prepared or cooked and, consequently, the amount of food that is disposed of as waste. Households prepare and serve more significant portions of food than they can consume, leading to more residues **[28]**. Household income affects not only food waste generation but also waste generation in its broadest sense **[29]**, **[30]**, **[31]**, **[32]**.

Machate [24] in the study, presents a strong, negative correlation between income in the household and the quantity of food loss generated by the households in the five selected suburbs in the city of Tshwane (South Africa). These results imply that the household's monthly income, the lesser the quantity of food waste generated. A significant number of possibilities can be attributed to these findings: the educational levels, employment status, ages, and other demographic factors of individual household members. The findings of this study are contrary to most previous studies. However, these results are consistent with the findings of **[33]**, who found no correlation between income levels and the amount of food wasted. Machate **[24]** states in his study that looking at the income level can reveal the living standards of the members of the households, which in his research meant that more than 50% of the sampled households lived below the poverty line. The author also states that the employment status of individual household members influences the monthly household income, which ultimately has proven to influence food waste generation directly.

We used the Chi-square test to test the established hypothesis that the amount of household expenditure on the purchase of chicken meat contributes to food waste. Contingency Table 6 provides information on the observed cell counts (expected cell counts) and the statistical evaluation according to the Chi-square test for each cell.

Table 6 Contingency table for testing the hypothesis of the impact of the household expenditure on the purchase of chicken meat and chicken products on the generation of food waste.

Expenditure on the purchase of chicken meat (€)	Expenditures affect	Expenditures do not affect	Boundary row totals
0	17 (56.30) [27.43]	272 (232.70) [6.64]	289
up to 10	38 (49.68) [2.74]	217 (205.32) [0.66]	255
10 - 15	68 (49.68) [6.76]	187 (205.32) [1.64]	255
15 - 20	59 (49.68) [1.75]	196 (205.32) [0.42]	255
Over 20	73 (49.68) [10.95]	182 (205.32) [2.65]	255
Boundary sums of columns	255	1054	1309 (total sum)

Source: Own research.

According to the Chi-square test, the result of the statistical evaluation is 61.6474 and a p-value $p \leq 0.00001$. There is a statistically significant dependence between the expenditure incurred for buying chicken meat and food waste at $p \leq 0.05$, i.e. food waste arises from a dependent variable.

A total of 255 respondents answered the question of the set household expenditure from the budget for purchasing chicken meat and chicken products per member and month in € (Figure 3). Of most respondents involved in the research, 73 (28.63%) reported expenditures on chicken meat and chicken products of over € 20 per member and month. Other respondents, numbering 68 (26.67%), indicated costs of chicken meat and chicken products per month per member for € 10 to € 15, but also € 15 to € 20 (59 respondents, 23.14%). Respondents followed this with lower expenditures below € 10 (38 respondents, 14.90%) and € 0 (17 respondents, 6.67%). In the case of expenses on chicken meat and chicken products in the amount of € 0, the respondents also stated the reason that they are vegetarians (4 respondents) or have their broiler chickens (6 respondents), or the respondents eat in the common dining room during working days where chicken meat is often prepared food, so they do not buy it (5 respondents), respectively. 2 respondents do not purchase chicken meat because its smell hinders it.

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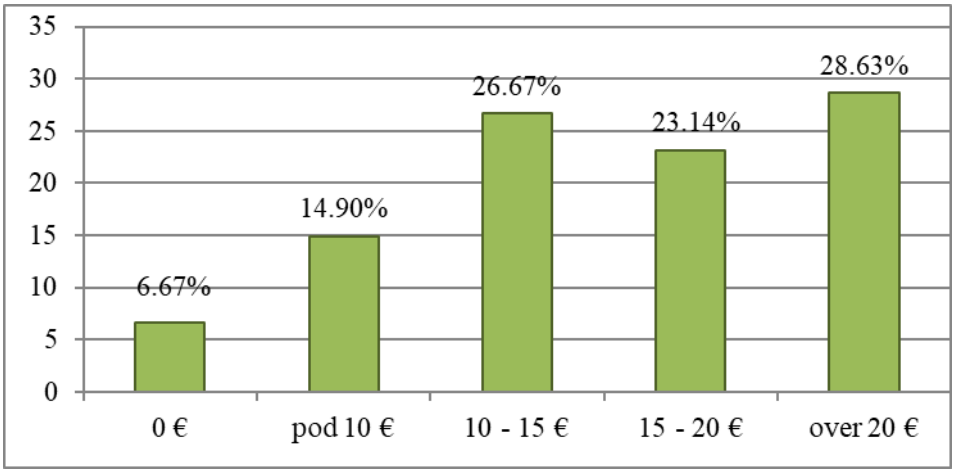

Figure 3 Household expenditure from the budget for buying chicken meat and chicken products. Source: Own research.

The increased demand for proteins from animal sources in consumer diets is related to urbanization growth, living standards, diet, livestock production growth, and consumer prices. The affordability contributed to making poultry meat of choice for consumers worldwide, especially in developing countries **[34], [35]**. Chicken meat and chicken products are globally popular, which can be explained by the fact that quality chicken products are available at affordable prices, although their production costs may vary [**36],** [**37], [38]**. Chicken meat is a popular type of meat; any religion does not limit it in comparison, e.g. to pork. It is characterized by relatively high nutritional value and dietary properties. It is a good source of protein and is low in fat and cholesterol. It is affordable for the consumer and is easy to cook. Respondents of households involved in the research also took a stand on the amount of losses of chicken meat from prepared food on a plate, i.e. uneaten chicken meat and skinless chicken per 1 household member per month, shown in Table 7.

For some respondents, 44 (17.25%) out of all household respondents 255, it was a problem to answer a numerical value in terms of the amount of chicken meat lost as part of the prepared dish on a plate without skin and bones. The individual questionnaires of the household respondents stated that they like chicken meat, so they also buy it and prepare it culinary, or they do not like chicken meat, but eat in the staff canteen, where there is very often chicken meat with side dishes.

Respondents also reported that children ate at home during Covid-19 online learning. The dishes did not like the prepared meals very much, including the meal with chicken meat. This may be related to a different cooking process or different food additives in the preparation of meals. This group of respondents stated in the questionnaire either a comment or an answer: I can't estimate, and I don't know.

Table 7 Amount of chicken meat waste from prepared food on a plate.

The loss of chicken meat from the prepared food on a plate	Percentage of respondents to the answer	The loss of chicken meat from the prepared food on a plate	Percentage of respondents to the answer
Various comments	17.25%	50 g	3.92%
0	59.61%	70 g	0.39%
Minimum	3.14%	100 g	3.92%
10 g	1.57%	150 g	2.35%
15 g	1.18%	200 g	0.78%
20 g	2.35%	250 g	1.18%
30 g	0.78%	300 g	0.39%
		500 g	1.18%

Source: Own research.

The overwhelming majority of 152 household respondents (59.61%) out of all involved respondents stated that the value of chicken meat waste from prepared food on a plate was zero. In this group, some respondents from the city and the municipality indicated that they keep a cat or dog at home, so they have no waste. The minimum losses of chicken meat (stated by the respondents) from the prepared food on a plate with chicken meat without a numerical value were expressed by eight respondents (3.14%). Other respondents reported waste of culinary chicken designed on a plate from 10 g (4 respondents, 1.57%) to 500 g (3 respondents (1.18%). Of the

44 respondents (17.25%) who expressed losses of chicken meat prepared and presented on a plate in numerical value, the most (10, 3.92%, and the same) stated 50 or 100 g.

The current worldwide production of broiler chickens is approaching 60 billion pcs per year **[39]**. Broiler chickens are transported for slaughter from their geographically dispersed farms. On-farm harvesting uses either manual or mechanical harvesting, placing them in crates, then loaded onto vehicles and transported to slaughterhouses **[40]**. The chickens are unloaded with crates from the cars upon arrival at the slaughterhouse and kept in temporary housing set up for various lengths of time or killed immediately **[41]**. Handling broiler chickens before killing them causes varying degrees of stress that threaten their welfare **[42]**. Collection and broiler chickens in poultry farms and handling are considered the most frequent injuries. The animals then suffer during transport to the slaughterhouse **[43]**.

We used the Chi-square test to test the established hypothesis that the size of a poultry farm affects the generation of food losses. Contingency Table 8 provides the following information on the observed cell counts (expected cell counts) and statistical evaluation according to the Chi-square test for each cell.

According to the chi-square test with Yates correction, the result of the statistical evaluation is 0.5333, and the *p*-value is 0.465209. There is no statistically significant dependence of $p > 0.05$ between poultry farms and food losses by the chicken mortality, i.e. food losses arise from an independent variable.

The respondents of the poultry farms were to comment on the losses of chickens caused by death during each fattening period from the housed dormitory and report the losses of chickens to deaths during fattening, harvesting, and poor health (Figure 4).

Table 8 Contingency table for testing the hypothesis of the impact of the size of poultry farms on generating food losses.

Poultry farms	Losses generate	Losses do not generate	Boundary row totals
Large enterprise	9 (7.50) [0.03]	6 (7.50) [0.03]	15
Smaller enterprise	6 (7.50) [0.03]	9 (7.50) [0.03]	15
Boundary sums of columns	15	15	30 (total sum)

Source: Own research.

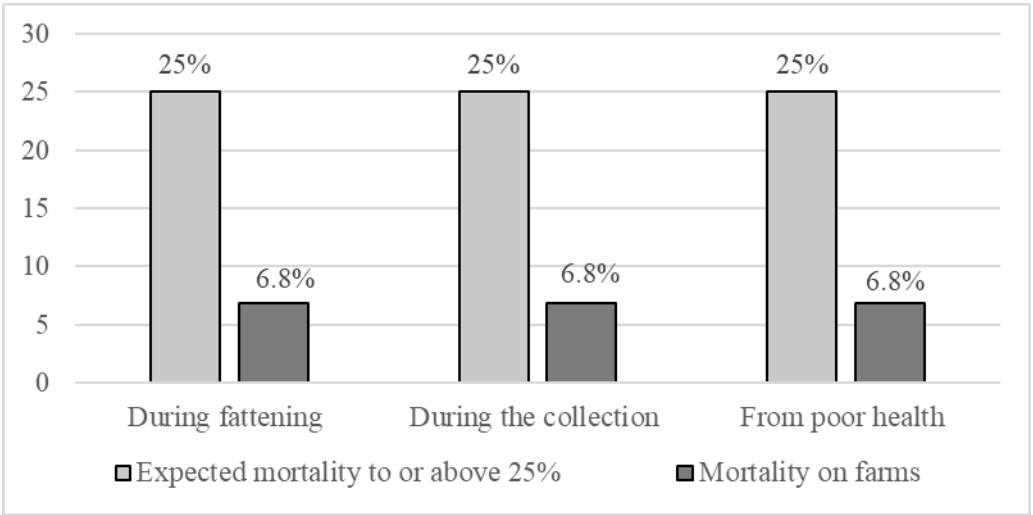

Figure 4 Respondents of poultry farms are aware of the causes of food losses - mortality. Own research.

We determined expected losses of up to 25% and over 25% as a tool for respondents. The poultry farms were also asked to comment on food losses during the transport of broiler chickens in the questionnaire. The addressed poultry farms order an animal transport service when they fill the hall with day-old chicks or harvest broiler chickens in the hall at the end of the fattening period. They are not monitoring the mortality of broiler chickens during transport.

Of the total number of broiler chickens that were filled with halls in poultry farms during fattening periods, the mortality losses of chickens averaged 6.8%. These losses evaluated for individual fattening periods ranged from 6 to 8%. Interestingly, lower mortality losses of broiler chickens were in a larger large-scale broiler chicken farm (6.44%, i.e. 30,600 to 42,375 pcs per fattening period). This agricultural company has been operating for many years and is managed by experts with university degrees in agriculture and many years of experience.
In a smaller poultry farm, larger losses were reported by respondents, with 6 to 8% (1,228 to 1,652 pcs per fattening period). In a smaller poultry farm, these losses represent an average of 7.33% (1,500 pcs per fattening period).

All respondents reported a generation of losses due to broiler chicken mortality altogether during the fattening periods. Respondents reported the same values of broiler chicken mortality during fattening periods in the hall, harvest, and ill-health. It is known from the literature that broiler chickens during harvest experience intense stress, similar to transport. This issue in poultry farms requires more attention in research.

Poultry farms must comply with the legislative measures for the protection of this type of livestock and apply the principles of welfare under the five fundamental freedoms and the legislative measures of the hygiene packages, and despite strict compliance, mortality occurs. Three interrelated factors are important for the breeding of broiler chickens: genetics, breeding conditions, and nutrition. Their effect in small deviations may have a different effect on the viability of the placed animals in individual fattening periods if they are not dangerous infectious diseases. Some manipulations with broiler chickens create a stressful behavioural pressure that results in a deviation from their natural behaviour. One of these manipulations is the collection of broiler chickens in the hall, described as a critical stage in breeding. In large-scale farms, it is probably challenging to divide the mortality of broiler chickens on the farm according to the cause, as we identified in the questionnaire. This issue is an open question for future research. Respondents reported an average loss of 54,623.67 kg caused by broiler chicken mortality on farms from the planned live weight when collecting chickens for one fattening period. The stated average amount of losses of broiler chicken mortality arises in poultry farms with a capacity of 510 to 565 thousand and a capacity of 20.21 to 20.66 thousand pieces. In a poultry farm with a higher broiler chicken breeding capacity, the losses of chicken mortality per fattening period ranged from 76,500 to 105,937.5 kg, and with a lower broiler chicken breeding capacity ranged from 3,070 to 4,130 kg. These losses of broiler chickenst the farm's economy, increase its costs and reduce profits. In line with the measures taken to reduce food losses, this issue is suitable for solution in future research from a social, economic, and environmental point of view.

A published study **[44]** recommends an appropriate procedure for handling broiler chickens at harvest in the hall to reduce mortality and suffering from bleeding, bruising, and fractures. Mortality is observed throughout the breeding period and of varying intensity in poultry farms **[45]**. The procedure is developed to calculate the weekly mortality, taking the number of dead broilers per week. Food losses (meat) from broiler chickens are related to the lack of technical equipment at the slaughterhouse level for the recovery of the edible part of chicken meat **[46]**. The yield of chicken meat may also be related to processing costs that are too high to allow commercialization or feed costs. There are currently major concerns about welfare, hygiene, and disease control, resulting from tremendous genetic pressure to increase meat production. Genetic pressure to improve the productive performance of animals adversely affects their well-being and innate immunity, and thus tolerance to disease. Genetic selection achieves improved breeding, disease control, and nutrition handling practices **[47]**. The transport of broiler chickens is considered a critical point in the chicken meat production chain **[48]**, which is explained concerning the possible consequences for the welfare of broiler chickens **[49]**.

It is recommended to address the process of reducing food losses in households:

- to buy food in retail in smaller volumes and more often without creating large stocks,
- to establish food sales closer to the consumer,
- reduce the amount of the prepared meals and submitted portions of the food,
- strictly control food labelling during purchase and storage,
- show more respect for the produced food (bread),
- strengthen legislative measures to change people's approach to reducing food waste,
- stimulate consumer education.

It is recommended to address the process of reducing food losses by chicken mortality in poultry farms:

- application of current knowledge based on science and research in the protection of broiler chickens (welfare),
- compliance with good poultry farm practices, including nutrition and safe feed,
- addressing more environmentally friendly practices through the handling of broiler chickens.

Our research on food losses and waste in Slovak households and poultry farms supports the definition of food waste reduction strategies according to the European hierarchy for waste prevention and management, which sets waste prevention as the preferred option. Strategies and targets for the prevention and recovery of food waste are

important, including waste management and food safety from an economic, social, and environmental point of view, to optimize the efficiency and effectiveness of data collection, evaluation, and enforcement.

The evaluated research results processed in the presented study are beneficial for the further development of science and have their use in practical conditions in the field of measures taken to prevent and reduce food losses.

CONCLUSION

The research shows that in Slovak households, the food waste is up to 40% and in poultry farms the average of the food loss is 6.8%, which is primarily caused by the mortality of broiler chickens. Household budget expenditures related to food waste per member and month were most often reported at € 5 (25.88%), with a small difference of up to € 5 (19.61) or € 10 (18.82%), € 15 and € 20 (14.12% and 13.32%), respectively. A statistically significant difference ($p \leq 0.001$) was found in the amount of food waste between the amount of household income per family member and the month and no statistically significant difference ($p > 0.05$) between the number of family members. Foods that generate the most household waste include fruit, vegetables, pastries, meat and dairy products, and prepared meals. Mold and rot were the most common causes of food spoilage. Broiler chicken mortality losses during breeding have been recorded as the cause of food losses in poultry farms. Suggestions for improvement were recommended to address the process of reducing food losses and waste in households and farms. By applying a practical approach of households and poultry farms to reduce food losses snd waste and supporting innovative solutions, it is possible to achieve gentle practices in ensuring the security of nutrition, food production, social and economic sustainability, and environmental protection in the Slovak Republic. Not only policy makers, food producers, and retailers, but above all households must realize that with the current economic, environmental, and geopolitical changes, it is not possible to generate as many food losses and waste as they have done so far.

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