# International Conference on Food Science

University for Business and Technology - UBT

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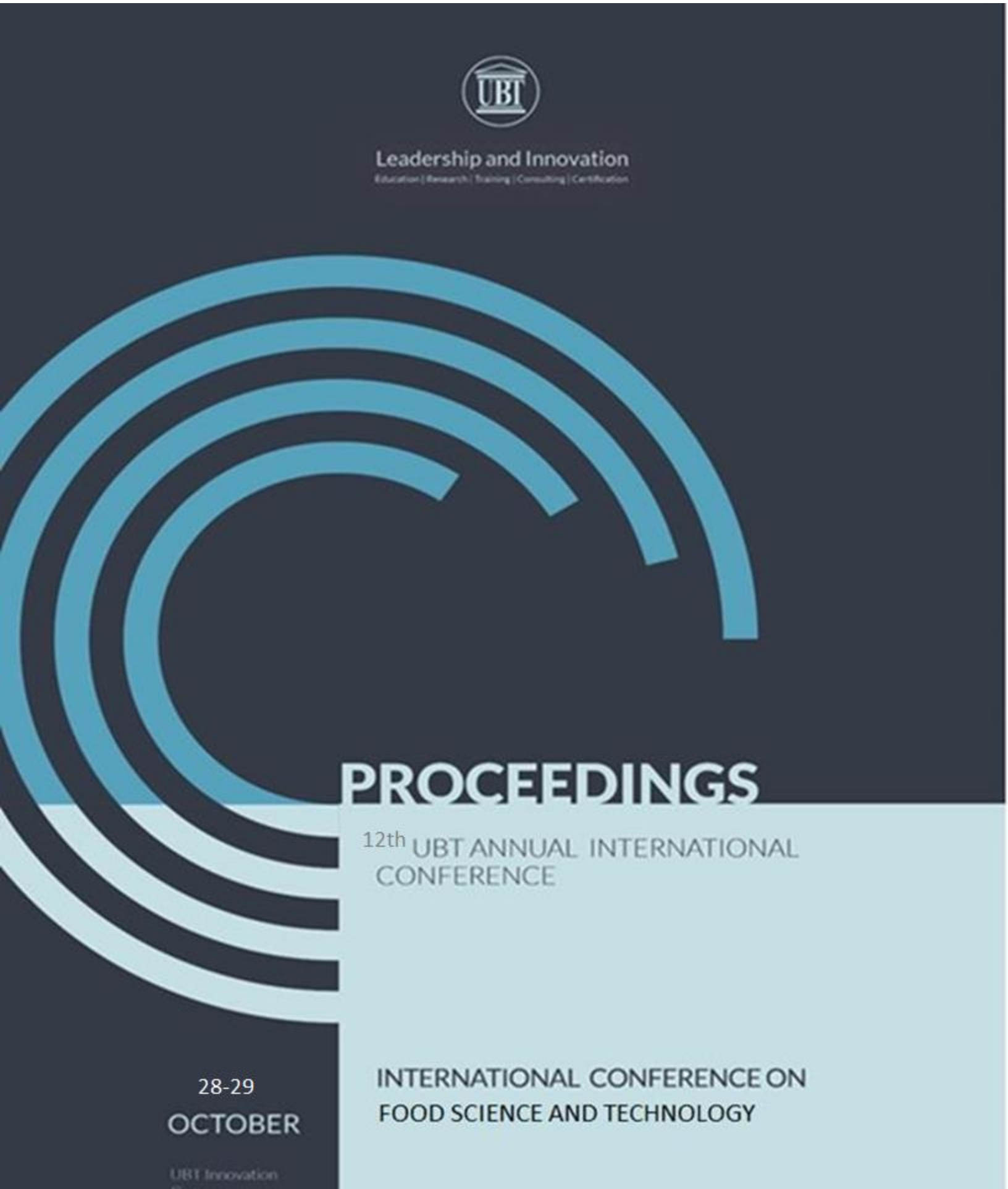
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12th UBT ANNUAL INTERNATIONAL CONFERENCE
28-29
OCTOBER
INTERNATIONAL CONFERENCE ON
FOOD SCIENCE AND TECHNOLOGY
UBT Innovation

Proceedings of the 12th Annual International Conference onFood Science and Technology

Edited by
Edmond
Hajrizi

# Conference Book of Proceedings International Conference

# Pristina, 2023

ISBN



International Conference on Business, Technology and Innovation Pristina, Kosovo 28-29

**Editor**: Edmond Hajrizi

**Organizing Committee:** Edmond Hajrizi, Hasan Metin, Visar Krelani, Hazir Cadraku, Retkoceri B, SelmaniF, Muhamet Ahmeti, Selmani F, Muhamet Sherifi, Kastrati A, Mirlinda Reçica



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## Editor Speech of IC - BTI

International Conference is the 12th international interdisciplinary peer reviewed conference which publishes works of the scientists as well as practitioners in the area where UBT is active in Education, Research and Development. The UBT aims to implement an integrated strategy toestablish itself as an internationally competitive, research-intensive institution, committed to thetransfer of knowledge and the provision of a world-class education to the most talented studentsfrom all backgrounds. It is delivering different courses in science, management and technology.This year we celebrate the 21th Years Anniversary. The main perspective of the conference is to connect scientists and practitioners from different disciplines in the same place and make them be aware of the recent advancements in different research fields, and provide them with a uniqueforum to share their experiences. It is also the place to support the new academic staff for doing research and publish their work in international standard level. This conference consists of sub conferences in different fields: - Management, Business and Economics - Humanities and SocialSciences (Law, Political Sciences, Media and Communications) - Computer Science and Infor- motion Systems - Mechatronics, Robotics, Energy and Systems Engineering - Architecture, In- targeted Design, Spatial Planning, Civil Engineering and Infrastructure - Life Sciences and Technologies (Medicine, Nursing, Pharmaceutical Sciences, Phycology, Dentistry, and Food Sci- ence),- Art Disciplines (Integrated Design, Music, Fashion, and Art). This conference is the majorscientific event of the UBT. It is organizing annually and always in cooperation with the partneruniversities from the region and Europe. In this case as partner universities are: University of Tirana – Faculty of Economics, University of Korca. As professional partners in this conference are: Kosova Association for Control, Automation and Systems Engineering (KA – CASE), Kosova Association for Modeling and Simulation (KA – SIM), Quality Kosova, Kosova Association for Management. This conference is sponsored by EUROSIM - The European Association of Simulation. We have to thank all Authors, partners, sponsors and also the conference organizingteam making this event a real international scientific event. This year we have more application,participants and publication than last year. Congratulation!

Edmond Hajrizi, Rector of UBT and Chair of IC – BTI 2023

# Përmbajtja

# Concerns about the high content of acrylamides in food: A comprehensive review

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**Abstract.** Acrylamide's presence in food has recently drawn considerable interest on a global scale. One of the antecedents of acrylamide is asparagine, an amino acid that is frequently present in both plant and animal proteins. Acrylamide is listed as a potential cause of cancer, abnormal birth outcomes, and nerve damage in people. It appears naturally in foods that have been heated to high degrees as a synthetic chemical. Acrylamide is generally associated to the Millard reaction, which is prevalent in foods that mostly contain asparagine and starch, and forms during high-temperature cooking such as frying, roasting, and baking. According to the FDA, although it's unclear exactly what risk acrylamide poses to humans, research investigations in animals' labs demonstrate that excessive quantities of the chemical caused cancer. Since acrylamide exposure is so high, it's important to recognize its hazardous effects, especially in nations where people are still mostly unaware of the danger's acrylamide poses to their health. This article gives a summary of relevant scientific data on the production of acrylamide, its potential health risks, and methods for reducing it in the food industry and at home. Depending on the producer, cooking time, temperature, and production process, different foods contain different amounts of acrylamide. To control the manufacture and use of acrylamide, some nations have put regulations and laws into place. For the purpose of regulating the manufacture and use of acrylamide, maximum amounts of acrylamide in foods have been established in the USA, Europe, Japan, and Canada, and which are expected to be updated in the coming year.

**Keywords:** Acrylamide, asparagine, food, hazardous effects, human health

## 1. INTRODUCTION

The recent years, the occurrence of acrylamide in various widely consumed foods presents a challenging issue and problematic for the food industry and its supply chain (Raffan S, 2019). Acrylamide (AA) - ($C_3H_5NO$) is an extremely reactive chemical molecule that can polymerize to create polyacrylamide (SFNA, 2002), a substance widely employed in many different sectors. The discovery of acrylamide in food, first noted by the Swedish Authority for Food Safety in 2002 (SFNA, 2002; Lofstedt, 2003), has since gained widespread awareness. Over the past two decades, there has been an increasing interest in study on AA because of its harmful effects on both humans and animals (Rifai, 2020; EFSA, 2015). Starchy foods are one of the primary sources of AA animals (Pruser KN et al, 2011; Nica-Badea, 2022).

In food processing the interaction between amino acids and reducing sugars do they exist. In this case acrylamide is visible in cooked food especially fried foods (Feng Zhu, 2022).

Well-known staples including coffee, bread, and potato goods, have high amounts of AA. According to EFSA (2015), when some foods are cooked at high temperatures (above 120ºC and in low moisture conditions) especially in foods containing asparagine and reducing sugars, including when baking, frying, or roasting, acrylamide can develop. It can be found in many different meals, such as coffee, breakfast cereals, french fries, and potato-based snack production (Gunduz, 2023).

Frenf Zhu in 2022 study found that vegetables, cereals, and potatoes were the primary contributors to acrylamide exposure, accounting for almost 90% of the total intake. Comparing frying, roasting, and baking potatoes, frying causes the highest acrylamide formation (FDA, 2022). Boiling and steaming do not typically form acrylamide.

Safe food advocacy Europe (safe), after a study conducted in 10 European countries, has found very high levels of acrylamide in about 500 food products analyzed and according to the notification from the Rapid Alert System on Food and Feed (RASFF) 2020- 21, AA contamination was 497 and 2690 µg/kg and exceeded the benchmark values in the EU by 4-5 times.

The European Commission's Regulation (EU) 2017/2158, addresses the control of AA in a variety of foodstuffs. This regulation, while not setting explicit legal thresholds, sets benchmark levels to motivate the food industry to implement measures for reducing AA content. Furthermore, in 2019 Food Drink Europe (FDE, 2019), developed a comprehensive Toolbox that outlines various strategies for managing AA levels, applicable at different points in the food processing chain. This paper gives a summary of relevant scientific data on the production of AA, its potential health risks, and the use of different strategies methods for reducing it in the food industry and home.

## 1.1 Formation and presence of AA in foods.

The formation of AA in foods is a complex process that involves various factors beyond the basic Maillard reaction between asparagine and reducing sugars. Factors like the type of food, its moisture content, and the cooking method (such as frying, baking, or roasting) significantly influence acrylamide production especially fried foods (Feng Zhu, 2022). Foods with higher carbohydrate content and low in proteins, like potatoes, grains and cereals, tend to produce more AA when cooked at temperatures above 120°C (Feng Zhu, 2022). Various factors influence AA production, including the type of food, cooking temperature, duration, moisture content, pH levels, and the presence of certain minerals. The conditions of cooking, especially higher temperatures, significantly enhance the generation of AA, a compound associated with potential health risks (Schuten, Slotboom, & Gijssel, 2004). Understanding these factors is essential for devising strategies to mitigate acrylamide levels in foods, risks contributing to safer consumption.

Common foods: where acrylamide can be found include Potato-based products, like french fries and potato chips fig.1. Baked goods such as bread, toast, crackers, and biscuits. Coffee and coffee substitutes that undergo roasting processes. Cereal products, including breakfast cereals. Snack foods that are fried or oven-baked. It's important to note that acrylamide formation is more likely in these foods when cooked at temperatures above 120°C (248°F).


**Fig.** Acrylamide formation in some foods

Many studies have been done to reduce AA in foods and according to Raffan (Raffan S, 2019) reducing the levels of acrylamide in bread would have much more impact on AA intake than reducing the levels in breakfast cereals or potato crisps.

### 1.2 Levels of AA in popular foods

Information regarding the occurrence of acrylamide in food products in Europe has been gathered since 2003 from different sources like ECJR and EFSA. The collected data has been scrutinized and presented in a series of published reports (CONTAM Panel, 2015; EFSA, 2009, 2010, 2011, 2012, 2015). In the study report (CONTAM Panel, 2015) shows that, selected foods (vegetable crisps, coffee substitute, coffee/dry, potato crisps & snakes, potatoes fries, biscuits, crackers & crisp bread, breakfast cereals, roasted nuts & seeds processed cereal-based baby food, cakes and pastas, soft, bread and non-cereal baby foods). The higher AA levels were found in vegetable crisps and coffee substituents. According to same source, reducing the levels of acrylamide in bread would have much more impact on AA intake than reducing the levels in breakfast cereals or potato crisps.

### 1.3 Toxicity of AA and health implications

AA in certain foods cooked at high temperatures, has emerged as a significant public health concern. AAy the International Agency for Research on Cancer (IARC) as possibly carcinogenic to humans in 1994. Classified as a 'probable human carcinogen' by IARC, AA has been linked to an increased risk of cancer in laboratory animal studies. Beyond its carcinogenic potential, studies suggest that AA exposure may also pose neurological risks and impact reproductive health (Rifai & Saleh, 2020). Furthermore, AA has demonstrated genotoxic, group 2a

carcinogenic, hepatotoxicity, immunotoxicity. reproductive toxicity and neurotoxic effects described for each category by some authors (Rifai & Saleh, 2020; Carere, 2006; IARC, 1994). The effects of this toxicity are described by scientific article (Başaran et al, 2023).

According to findings of the (IARC) by the Joint FAO/WHO, average human intake of AA is valued to be 0.4 μg/kg bw/day from two years of age, though consumption may vary generally from 0.3 μg/kg bw/day to 5 μg/kg bw/day. The estimate of average daily human intake was 1 μg/kg bw/day, and it can be 4 μg/kg bw/day for high consumers. Several toxic effects of AA are summarized and described by Dilini N. Perera with collaborators (2021) Previous results of epidemiological studies on dietary acrylamide intake and cancers of the urinary tract, cancers of the gastro-intestinal tract, cancers of reproductive organs, and cancers of the respiratory tract, are presented by (CONTAM Panel, 2015). Many investigations have demonstrated that AA significantly affects a variety of physiological processes, such as the transmission of signals in peripheral nerves, the regulation of enzymatic and hormonal processes, muscular function, reproduction, and so forth. Given its presence in commonly consumed foods, understanding and mitigating the health risks associated with dietary acrylamide exposure is crucial in food safety and public health research.

### 1.4 Effect of Processing Conditions and food property in AA formation

Many studies on AA formation in some foods have shown that the major factors contributing to the AA production are frying temperatures & time, different frying oils, pH, Water Activity, soaking, Blanching etc. (A. Torang, 2016; Khalaf H.H.A., 2015).

#### *1.4.1 Effect of pH, Water Activity, and Fermentation*

*pH levels*

Were pH levels influence the formation of AA, lower pH indicates with lower AA formation. Effect of pH, Water Activity, and Fermentation on AA formation are mentioned and demonstrated by many authors (Rifai & Saleh, 2020). Were pH levels influence the formation of AA, lower pH indicates with lower AA formation. Decreasing the pH of the soaking solution has been demonstrated to prevent the formation of the Schiff base, where the nucleophilic amine group (NH2) is converted into the non-nucleophilic protonated-NH3þ, which is a precursor to AA formation.

*Water Content*

The quantity of water within food significantly impacts the level of acrylamide (AA) in the food. Studies indicates that AA formation in foods occurs when the water activity (aw) ranges from 0.4 to 0.8. However, when water activity falls below 0.4, there is a decrease in acrylamide production (Rifai&Saleh 2020; Rydberget al.2005; Vleeschouwer et al., 2006) activity and moisture content are interconnected parameters, meaning that foods containing less than 5% moisture content are more prone to engage in the Maillard reaction and produce AA. In the Ciesarove study (Ciesarova, 2023), it was noted that the lowest formation of AA occurred when the water content was between 25 and 40%; outside this range, there was an increase in AA concentration.

*Fermentation*

The generation of AA in food is also influenced by fermentation. For example, lactic acid fermentation has been noted as effective in decreasing AA formation in potato products, particularly when employed in conjunction with blanching.

*Colour*

Also, it has been found that AA is formed during the browning process, which is a result of the Maillard reaction between reducing sugars and asparagine at temperatures over 120 °C. Colored products are also formed in foods during heating because of Maillard reaction. Given that color is a measurable attribute, it can serve as an indicator for other products of the Maillard reaction, such as AA. The CIE a* color value is correlated with the AA content in coffee or colour changes in fried potato (Vural, 2006; Pedreschi, 2005).

#### *1.4.2 Effect of Processing Conditions*

*Frying Time and Temperature*

In general, the temperature and duration of frying have been proven to have a substantial impact on the quantity of acrylamide (AA) generated and are regarded as the most crucial factors influencing its presence in fried potato

products. Some studies (Israilides, 2015) reported that, when potato chips frying at temperatures 180-190°C, AA concentrations showed a rapid, exponential rise as the frying period concluded. Elevated temperatures and lengthier cooking times are correlated with increased AA levels. (Gökmen, 2008). Numerous research studies on bakery items have shown that the formation of AA is slower at lower temperatures, while at higher temperatures, its maximum level is attained quickly. The formation of AA is also affected by the method of heat transfer (Qingqing Jiao et al., 2022; Mogol & Gökmen, 2014; Ahrné et al., 2007). It seems that, formation of acrylamide can be decreased in fried food by lowering frying temperature below 175 °C (GERTZ et al., 2003).

*Use of Additives*

Some studies examined the effect of some additives as a mitigation strategy to reduce the levels of AA. Amino acids as glycine, alanine, lysine, glutamate and glutamic acid have been found to reduce acrylamide formation in heated potatoes (Rydberg et al., 2003), the herbs Rosmarinus, ascorbic acid or citric acid. This is probably since AA information is minimized at low pH values (<pH5) (Theodoros, 2015).

Enzymes, as biological catalysts, may play a significant role in mitigating AA formation during cooking processes in various food products. Some results suggest that enzymes, such as asparaginase, proteases, amylases, and lipases, hold promise in reducing acrylamide levels in foods (Covino et al., 2023; Paper, T., 2019; A. El-Sayed et al, 2023). The degree of reduction varies depending on the type and concentration of the enzyme used. Their potential to catalyse reactions that interfere with AA formation pathways highlights their suitability as natural agents for AA mitigation. Enzymes like asparaginase are frequently used in food products to inhibit the formation of AA. For these enzymes to be most effective, it's essential to maintain a balance in the availability of substrate, the moisture content, and the extent of mixing (PAPER, 2019). Importantly, the preservation of food quality attributes underscores the feasibility of using enzymes in culinary applications.

Research suggests that specific vitamins such as vitamin C (ascorbic acid), vitamin E (tocopherol), and vitamin B3 (niacin) hold the potential to effectively lower acrylamide concentrations in food products, if they applied to the food either through direct infusion or as part of a marinade (Wang& Xu, 2014; Zeng et al, 2009; Daniels, 2009; Rifai&Saleh. 2020).

*Soaking/ Brining*

The effect of pre-treatments like food soaking have been proven to have a substantial impact on the quantity of AA generated on AA concentration of in potato chips. Soaking or blanching prior to frying can reduce AA formation (Grob et al., 2003; Tomás, 2017; Torang& Alemzadeh, 2016; Khalaf et al. 2015; Bunger et al. 2003. In a study (Khalaf H.H.A., 2015), with soaking potato chips in $CaCl_2$ 1-2% and acid citric 0.5-1%, concludes that soaking of potatoes before fraying in calcium chloride 2% and citric acid 1% for 60 min can reduce the formation of AA up to 83 %. Jung et al., 2003 reported that soaking in an acidified solution, using vinegar (mixed in a 1:3 ratio with water) or 2% citric acid, can lead to a reduction of acrylamide levels by up to 75%. (Israilides, 2015). This process works by lowering the pH of the solution due to the action of the acids, as reported by Jung et al., 2003. It's important to note that the effectiveness of salt in reducing AA formation depends on several factors, including the type of food, the cooking method, and the concentration of salt used.

Another study has shown that soaking blanched potato strips in an asparaginase solution at 40°C for 20 minutes reduces AA by 60% compared to blanched strips without enzyme treatment (Pedreschi, 2008)The creation of AA experienced a reduction exceeding 80% when potato slices were immersed in a 3% solution of either lysine or glycine before the frying process (Heong et al, 2005). In the study of (Andrea Bunger, 2003) found that potatoes immersed in a CaCl2 solution exhibited a 95% decrease in acrylamide formation during frying, without adversely impacting the sensory qualities of the potato strips.

*Blanching*

Blanching is conducted to decrease the concentration of reducing sugars in raw potatoes, as these sugars could lead to elevated acrylamide (AA) levels. (Gunilla et al, 2010). Additionally, blanching in hot or warm water has been found to decrease the acrylamide content in French fries. With higher blanching temperatures and longer durations, an increased amount of glucose and asparagine are extracted, resulting in French fries containing reduced acrylamide (AA) levels. (Zhang, 2018).

Blanching potato strips in sunflower oil at 150°C for 43 seconds exhibited a more substantial reduction in acrylamide (AA) precursor levels, specifically asparagine and reducing sugars, resulting in a lower final AA content compared to soaking them in water.

Utilizing lower temperatures for frying (around 120 °C) and pre-frying blanching in hot water significantly reduces the acrylamide levels in potato chips (Pedreschi et al., 2004) showed that Blanching effectively removes glucose and asparagine extracts from potato slices, resulting in reduced acrylamide formation during frying. Blanching

treatment reduced the acrylamide content in potato chips in 68%, 75% and 49% at the frying temperatures of 120, 150 and 180 °C, respectively.

*Effects of Different Frying Oils*

Many studies examined the effect of different types of oil on AA formation (Klostermann, 2002; Daniali et al., 2016; Başaran& Turk, 2021; Research, 2009; Daniali2016; Ahmad, 2021). In Ahmed's study 2021, it was found that the choice of oil had a significant impact on the acrylamide levels in beef nuggets, whereas the number of frying cycles did not influence it. In the 2002 research conducted by (Gertz&Klostermann, 2002), where six varieties of oil were examined, it was indicated that palm oil had a significantly greater tendency to form acrylamide during deep-frying compared to the other oils studied. But this study didn't observe a significant correlation between oil qualities attributes and acrylamide content. Another study by Varzakas (Varzakas et al, 2016) analyzed and reported that while the average acrylamide levels in olive oil and soybean oil were higher than in corn oil, the differences were not statistically significant ($p<0.05$), owing to the considerable variation in the estimated acrylamide content among these oils.

**1.5 Regulatory situation**

Acrylamide legislation varies globally, with different countries implementing various regulations to address the presence of acrylamide in food products. In the European Union, for instance, the European Commission issued Regulation 2017/2158 in 2017, establishing mitigation measures and benchmark levels for reducing the presence of acrylamide in food. This regulation recommends practices to limit acrylamide formation and defines benchmark levels for at-risk food categories. while 2019, the Commission Recommendation (EU) 2019/1888 on the monitoring of the presence of acrylamide in certain foods, recommends to competent authorities and food business operators to monitor the presence of acrylamide in such food in view of the adoption of possible risk management measures, which should complement those already provided by Regulation 2158/2017. In other parts of the world, including the US, Canada, and Asia, acrylamide content in food products is carefully monitored by health bodies and regulatory agencies, especially in products targeting children, due to concerns about acrylamide's neurotoxicity and potential cancer risk.

The EU Acrylamide Regulation (EU_2017/2158) establishes maximum levels of acrylamide in specific food categories as well as guidelines (EU_2019/1888) for reporting and monitoring acrylamide levels in food. In order to lessen the development of acrylamide in food, it also establishes standards for food production process monitoring.

**Table1**. Benchmark levels for acrylamide in food that have been set in EU regulation No. 2017/2158 are as follows:

| **Food Category** | **Benchmark Levels (µg/kg)** |
|---|---|
| French fries (ready-to-eat) | 500 |
| Potato crisps from fresh potatoes and from potato dough, Potato-based crackers<br>Other potato products from potato dough | 750 |
| Fried potatoes | 500 |
| Sweet pastries | 500 |
| French fries (cooked and ready to eat) | 200 |
| Soft bread | |
| Wheat based bread | 50 |
| Soft bread other than wheat-based bread | 100 |
| Breakfast cereals (excl. porridge) | |
| bran products and whole grain cereals, gun puffed grain | 300 |
| wheat and rye-based products | 300 |
| maize, oat, spelt, barley and rice-based products | 150 |

| | |
|---|---|
| Biscuits and cookies / wafers | 350 |
| Crackers with the exception of potato-based crackers | 400 |
| Crispbread | 350 |
| Ginger bread | 800 |
| Products similar to the other products in this category | 300 |
| Coffee and substitutes | |
| Roast coffee | 400 |
| coffee substitutes exclusively from cereals | 500 |
| Instant (soluble) coffee | 850 |
| coffee substitutes exclusively from chicory | 4000 |
| Baby foods, processed cereal based foods for infants and young children excluding biscuits and rusks. | 40 |
| Biscuits and rusks for infants and young children | 150 |

The benchmark levels also are described by (Rifai & Saleh, 2020) for max. and min. benchmark levels of AA in foods. The mitigation measures to be applied by food business operators are set in annex II. referred to I article 2 of Regulation (EU) 2017/2158. Alo, they have been shown/ instructed in CODE OF PRACTICE FOR THE REDUCTION OF ACRYLAMIDE IN FOODS_ CAC/RCP 67-2009. The European Union's regulations on the presence of acrylamide in food have been guided by a series of EFSA reports arising from analyses of these data.

## 2. MATERIALS AND METHODS

Numerous scientific studies AA, methods of detection, and ways to lower acrylamide have been conducted on the synthesis of AA levels in the food industry as well as through legislative enforcement and restriction. Some techniques for measuring AA:

- High-Performance Liquid Chromatography (HPLC): One of the most used techniques for determining the amount of acrylamide in food is HPLC (Elbashir, 2014). With its excellent sensitivity, this approach can identify acrylamide at incredibly low quantities.
- Gas Chromatography (GC): Another popular technique for determining the amount of acrylamide in food is GC. Additionally exceedingly sensitive, this approach can identify very low acrylamide levels.
- Mass Spectrometry (MS): MS is an extremely sensitive technique for determining the amount of acrylamide in food. This technique, which frequently works in tandem with HPLC or GC, can identify very low concentrations of acrylamide.
- Immunoassay: This technique uses antibodies to determine the amount of acrylamide in food. With its excellent sensitivity, this approach can identify acrylamide at incredibly low quantities.
- Enzyme-Linked Immunosorbent Assay (ELISA): ELISA uses antibodies to determine the amount of acrylamide in food. Because of its high sensitivity, this approach can identify even very low acrylamide levels.

## 3. CONCLUSION AND RECOMMENDATIONS

The challenge of AA in widely consumed foods is a significant concern for the food industry. In food, acrylamide can form from the reaction of naturally occurring sugars and the amino acid asparagine when heated to high temperatures. This reaction, called the Maillard reaction, is responsible for the characteristic golden-brown color and flavor of many cooked foods, which results also harmful by-products, including the infamous toxicant acrylamide. Knowledge of both recipe and processing factors in acrylamide generation and mitigation is the key on acrylamide reduction. We recommend using the following steps as a strategy to cut down acrylamide in foods:

Increase consumer awareness about the risks of acrylamide:

- Choose low-sugar and whole-grain goods for healthier options.
- Cook meals at lower temperatures and for shorter durations to reduce acrylamide formation.
- Instead of frying or roasting, choose alternative cooking methods like boiling or steaming

- Avoid burning and overcooking meals to prevent excessive acrylamide production.
- Steer clear of very brown areas in food, as they tend to contain the highest levels of acrylamide.
- Be aware that acrylamide forms in coffee during the roasting of beans, not during the brewing process at home or in restaurants.
- Bake and toast bread and other baked goods to a light brown color, rather than dark brown, to minimize AA.
- Cook cut potato products, like frozen French fries or potato slices, to a golden yellow rather than brown to reduce AA.
- Aim for a light golden colour when cooking, especially to avoid browning fries.
- Soak potatoes in water before cooking to help prevent acrylamide formation.
- Store potato tubers at temperatures between 8-12 C and never in the fridge to reduce acrylamide formation.
- Industries should work to reduce acrylamide levels in baked goods and ensure compliance with regulatory standards.
- Combine regulatory measures with scientific advancements and industry collaboration to ensure our favourite foods are both delicious and safe.

Future research should focus on developing new cooking techniques and exploring the role of diet diversity in further minimizing acrylamide exposure. As consumers become more aware of these issues, it is crucial that the food industry and regulatory bodies continue to provide clear guidelines and support healthier cooking practices. Together, these efforts represent a comprehensive approach to reducing the risks associated with acrylamide, thereby contributing to a healthier society.

Since, Chemical composition of foods plays an important role in the formation of AA and the quality of foods. Then, the Knowledge of both recipe and processing factors in acrylamide generation and mitigation is the key on acrylamide reduction.

**Declaration of Conflicting Interests**

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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# The influence of ecological packaging design on consumer perception of purchasing food products: a case study in Ulqin

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**Abstract.** Due to environmental problems from food packaging, in recent times the tendency to use different techniques for environmental protection and reducing waste from packaging has increased significantly. The main purpose of this paper is to research and assess the impact of the design of ecological packaging as a method for reducing waste from food packaging, and the impact of the ecological packaging design on consumers' perception of purchasing food products. The research was developed in the form of a review of other researchers as well as through a survey by Google Docs., in Montenegro. The study included 300 people who participated by filling out an online questionnaire. This paper further elaborates on the research findings by comparing age groups, gender, perception of ecological packaging, consumer awareness, and the main problem that pushes consumers not to try to change their lifestyle for a cleaner environment and derives the results of analyzes that best summarize the problem and lead to its solution, especially the possibility for its solution. The tool used to analyze the answers is the IBM SPSS program, through which the statistical and graphic data for the choices of the participants in the questionnaire were obtained. This study makes diverse contributions in terms of theory, methodology, and policy-making, and with the recommendation for packaging industries to design packaging with ecological designs that stimulate the curiosity of consumers for their purchase.

**Keywords:** Environmental protection, food package, ecological design.

## 1. INTRODUCTION

Based on scientific researches, three crucial obstacles to the purchase of eco-friendly packaging have been identified. First, consumers require assistance in recognizing eco-friendly packaging; because while consumers primarily consider the packaging material itself and eco-labels, they also take into account other aspects of package design, such as colors and images of "nature" that can be deceptive. Second, it is evident that consumers lack knowledge, particularly regarding new packaging materials like bio-based packaging. Third, many of the reviewed studies provide proof that other product characteristics such as price and product quality are more significant to consumers than eco-friendly packaging (Ketelsen, Janssen, & Hamm, 2020). However, some studies documented a significantly higher willingness on the part of consumers to purchase and pay for eco-friendly packaging and products with reduced packaging compared to products with standard packaging, indicating an overall positive attitude. Sustainable packaging is the type of packaging that can offer the necessary protection conditions for food, but simultaneously it is biodegradable and can be disposed of as organic waste in landfills to biodegrade through a natural process. In this manner, sustainable packaging becomes part of the local economy (Athanassiou, 2020).

Packaging has undergone significant changes over time due to advancements in technology, transportation, and society. These factors have influenced various aspects of our lives, including the manner in which products are packaged. Packaging serves as the initial point of contact for consumers when they come across a product, thus it holds utmost importance in reflecting environmental values and promoting eco-friendly practices. One approach to accomplish this is by utilizing "biodegradable packaging", which finds explanation in the article "Biodegradable packaging - A sustainable approach" (Ambrose, 2019). Biodegradable packaging is designed in a manner that rapidly decomposes, ensuring minimal harm to the environment. Furthermore, it is crafted using materials that are easily recyclable and can be reused. Another effective method of promoting environmental consciousness through packaging is the utilization of eco-labels. These labels, also referred to as ecological labels, encompass symbols or logos that signify a product's eco-friendly nature and adherence to specific standards (Khan Md Raziuddin Taufique, 2014). By incorporating eco-labels, consumers are aided in recognizing and selecting sustainable packaging options in contrast to conventional alternatives, enabling them to comprehend the associated advantages.

Hence, it becomes imperative to establish distinct and consistent indicators that facilitate consumers in distinguishing and appreciating packaging that is truly "environmentally friendly". Eco-labels or ecological labels emerge as one of the most efficacious means to accomplish this objective. Eco-sensitive packaging has the potential to capture the interest of environmentally conscious consumers, as it can have a positive impact on their purchasing decisions. Products labeled as eco-friendly offer distinct advantages for the environment when compared to their regular counterparts. These benefits include reduced energy, water, and raw material usage, as well as decreased emissions during production and consumption (Phil, 2004).

The aim of this research is to delve into consumers' perception of eco-friendly packaging specifically for packaged food items. This study aims to examine how individuals perceive environmentally conscious packaging and whether it influences their buying habits, prompting them to become more eco-conscious in their choices.

## 2. METHODOLOGY

The study examines the influence of environmentally conscious packaging design on consumer perceptions regarding the purchase of food items and its potential for reducing food packaging waste. Packaging plays a crucial role in safeguarding food from production to consumption, while also catering to the demands of a modern lifestyle that values convenience and variety in food options. The primary objective of this research is to investigate how the use of eco-friendly packaging design impacts consumer decision-making processes. To gather data, a quantitative methodology was employed, utilizing an online survey conducted via Google Docs. The survey targeted 300 individuals aged between 18 and 60 years residing in Ulcinj, Montenegro. Comprising of 18 questions, the survey aimed to evaluate how green packaging design influences consumer perceptions when purchasing food products. The research questions and hypotheses revolved around several key themes, including identifying the types of food packaging that are more environmentally friendly, exploring consumer strategies to minimize packaging waste, gauging consumer awareness regarding the environmental impact of food packaging, and assessing consumer evaluations of packaging sustainability and its significance to them. The hypotheses sought to examine the influence of green packaging design on consumer behavior and perception. The collected data was analyzed and the hypotheses were tested using the IBM SPSS program.

The subsequent analyses were conducted to address the research inquiries and test the assumptions:

RQ1: How can consumers decrease packaging waste?

To address this question, the survey data was analyzed to comprehend consumers' attitudes and behaviors related to diminishing packaging waste. Descriptive statistics and inferential tests, have been used to compare different groups of consumers and their attitudes towards reducing packaging waste.

RQ2: How informed are consumers about the waste caused by food packaging?

This inquiry was tackled by examining the survey data to evaluate consumers' understanding of the ecological effect of food packaging waste. Explanatory data and measures of central tendency have been used to summarize the degree of understanding among the survey participants.

H1 - Consumers find it challenging to invest (paying more) in products with environmentally friendly packaging as a result of uncertainty and without informing them until they are fully persuaded of the risk and issue it presents to the environment and everyone's health, contamination with waste lots of plastic packaging or other polluting materials.

To test this assumption, inferential statistical tests, have been used to examine the relationship between consumers' willingness to pay more for products with environmentally friendly packaging and their level of understanding and perception of environmental risks associated with traditional packaging.

H2 - The society has not been informed about the actions that should be taken to minimize and contribute to the protection against environmental contamination from the packaging of food products.

This assumption may have been tested using explanatory data to evaluate the overall level of societal understanding and information about actions to minimize environmental contamination from food packaging. Additionally, inferential tests, have been used to examine the association between societal understanding and demographic variables. The use of these analyses allowed to draw conclusions and make recommendations based on the findings, contributing to the comprehension of the impact of environmentally friendly packaging design on consumer behavior and perception.

## 3. RESULTS AND DISSCUSION

The study aims to investigate how consumers can diminish the amount of waste generated from packaging and enhance their understanding of the environmental consequences associated with food packaging waste. The passage delineates a range of tactics that consumers can implement to decrease packaging waste, including purchasing items

with reusable and recyclable packaging, opting for discounted products to conserve fuel resources utilized in transportation, and selecting products with packaging that can be locally recycled. Additionally, it underscores the significance of educating and promoting a culture that minimizes the usage of plastic bags and other detrimental materials. Based on the comprehensive survey, the second set of four questions pertaining to this research query are the most pertinent, as they approach the same topic from various angles. Provided below is an alignment chart inserted amidst these questions to facilitate the necessary visualization required for analysis. For better visualization, the questions are:

Q5 - The design and composition of ecological packaging, influence and have priority in your choices of food products.

Q6 - Glass or metal packages, unlike plastic ones, after consumption, use them further for placing other foods.

Q7 - Ecological packaging and their proper use can halve the amount of waste that accumulates at the domestic and local level.

Q8 - The amount of waste can be reduced more if individuals pay attention to the use of ecological packaging rather than collecting and throwing away waste.

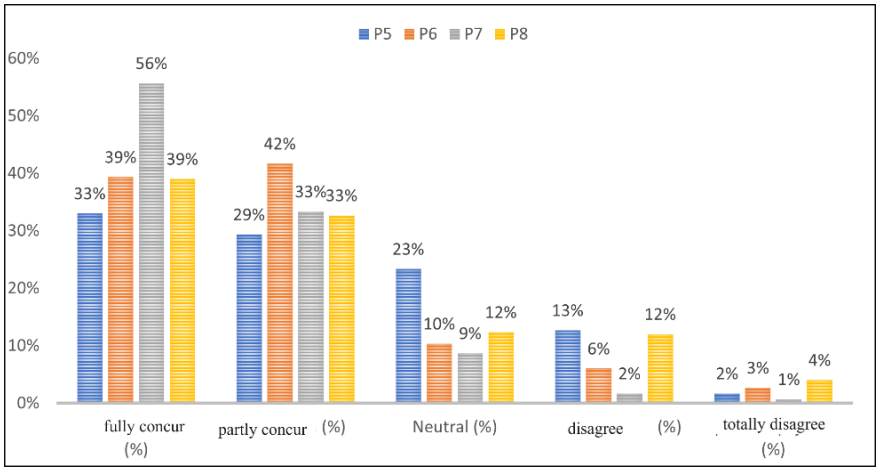


**Figure 1.** Compliance chart for questions 5,6,7 and 8 of the questionnaires

According to the compatibility chart, it can be observed that customers generally concur with the findings. However, there is less agreement regarding the influence of design and composition of eco-friendly packaging on their choices. The chart reveals that 33% of participants strongly agree, 29% somewhat agree, 23% are neutral, and 15% disagree. Furthermore, the text delves into the notion that individuals value environmental protection and prioritize ecology in their living environment, which amplifies their curiosity about the mere theoretical nature of social responsibility and its lack of practical implementation. The agreement graph pertaining to inquiries 5, 6, 7, and 8 highlights those participants, particularly the survey respondents, overwhelmingly support the notion (at a rate of 89%) that adopting environmentally friendly packaging and utilizing it appropriately can effectively halve the accumulation of waste at both household and local levels.

The research findings reveal a heightened consumer consciousness regarding the environmental impact of food packaging waste. Moreover, consumers are eagerly embracing sustainable packaging practices as a means of contributing to environmental preservation. Nevertheless, there remain certain gaps in both consumer awareness and behavior, as well as societal understanding and information regarding the mitigation of environmental pollution stemming from food packaging. In addition, the study delves into the comprehensive examination of Lynsey Hollywood's 2013 research, which hailed plastic as a secure and convenient packaging material. The research explores the extent to which consumers are cognizant of the environmental consequences of food packaging waste and the extent to which they are adjusting their behavior accordingly to minimize waste generation. Drawing upon the extensive research conducted and a recent 2021 sustainable consumption report from Germany, it becomes abundantly clear that the majority of consumers are indeed aware of the issue and are actively modifying their shopping habits to curb waste production. In fact, over half of the respondents in the report firmly believe that their individual actions can significantly contribute to environmental preservation. These concerns manifest on a larger scale, with a staggering 50% of respondents affirming that they have altered their shopping behavior in pursuit of

sustainability. This includes opting for alternative products, exploring new stores, and, in some cases, being willing to pay a premium. Furthermore, more than 25% of consumers actively avoid purchasing items that they deem insufficiently environmentally friendly. Additionally, one-third of respondents assert that sustainability factors exert a strong influence on their food purchasing decisions.

Despite of the theoretical preference for sustainability, the high cost still acts as a major hurdle for numerous consumers, with 40% confessing that sustainable products are excessively pricey. Companies and brands that disregard the importance of sustainability and environmental preservation may encounter a gloomy outlook. The findings of the survey disclose that respondents acknowledge their contribution to the problem of environmental pollution and the wastage of food packaging. One particular query in the survey (question 9) asserts that the extensive volume of waste in the environment poses a direct threat and sparks worrisome concerns regarding future well-being. This statement garners an overwhelming 96% agreement from the respondents. However, in question 11, which queries whether respondents are willing to pay additional costs for food items packaged in an eco-friendly manner, only 66% respond affirmatively, while 25% remain neutral and 9% respond negatively. This indicates that despite their awareness that paying more is a means of aiding their future and well-being, as confirmed by the subsequent discovery with an 87% agreement, they are unwilling to compromise their savings.

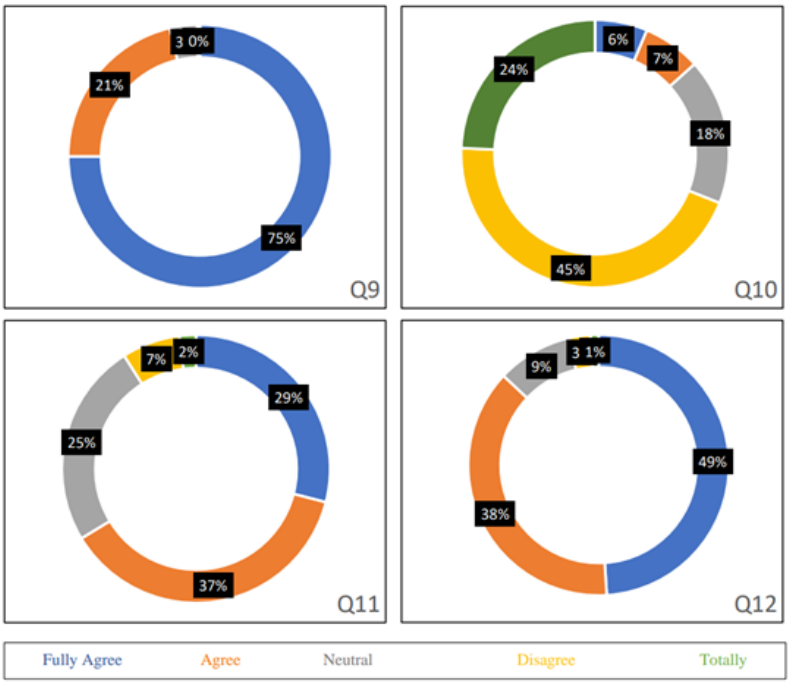


Figure 2. Compliance chart for questions 9, 10, 11 and 12 in the questionnaire

The second research query scrutinizes the extent of consciousness among consumers regarding the waste generated by food packaging. It is evident from the results that consumers, as a general rule, acknowledge the ecological repercussions of food packaging waste and express a willingness to embrace sustainable packaging methods to safeguard the environment. However, there remains room for improvement in terms of consumer awareness and conduct, as well as social awareness and information on how to mitigate environmental pollution stemming from food packaging. The chapter dedicated to data analysis in this study delves into the survey responses, shedding light on disparities in viewpoints across various age groups and genders. For instance, the outcomes demonstrated that younger individuals favored utilizing their own means of transportation prior to purchasing fresh food products, while females tended to bring their own bags or utensils when acquiring such items. Additionally, the findings revealed that the majority of participants were cognizant of the significance of eco-friendly packaging and its impact on the environment. In conclusion, this study furnishes valuable insights into consumer conduct and perceptions regarding the design of eco-friendly packaging and its environmental implications. The findings indicate a growing awareness among consumers regarding the importance of sustainable packaging, although discrepancies in viewpoints based on age and gender still persist. Furthermore, the study highlights the challenges and opportunities

associated with promoting sustainable packaging practices among consumers. These findings possess the potential to inform policymaking and industry practices, as well as facilitate the development of targeted interventions aimed at fostering consumer awareness and sustainable packaging.

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## 4. CONLUSIONS AND RECOMMANDAIONS

Since, ecological signs on packaging have an impact on consumer perception and play an important role in reducing packaging waste and protecting the environment from packaging waste, this study leads to the recommendation that packaging industries design packaging with ecological designs that encourage the curiosity of consumers for their purchase, and in Collaboration with Environmental Organizations, the Prioritizing of Use of Sustainable Materials that are recyclable, biodegradable, or made from renewable resources. This approach not only reduces waste but also educates consumers about sustainable alternatives to traditional packaging materials. Using universally recognized symbols and clear messages about the product's environmental impact can inform and educate consumers. This approach helps in making an emotional connection with consumers Also, in coordination with the legislative measures in force, ensuring that packaging designs comply with existing environmental laws and regulations and staying updated with changing legislation, to achieve a level of reduction of packaging waste and environmental protection. This strategy can effectively contribute to a broader effort in environmental protection and package waste reduction.

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# Investigation of beta-lactam antibiotics residues in fresh cow's milk

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**Abstract.** The presence of beta-lactam antibiotics in milk as raw material for other dairy products is prohibited by legal regulations. The research on the presence of beta-lactam antibiotics in milk was done during the six months (January – June) 2021, including 181 milk samples where 1 sample represented about 3000 liters of milk from an average of 60 farms per day. The analysis of the presence of beta-lactam antibiotics in the researched samples was carried out through the ROSA Pearl Reader Charm test. It turns out that the results of residues of beta-lactam antibiotics in fresh milk samples range from a low value of 0.014 µg/kg in May to a high value of 2.729 µg/kg in April and with the general average for all samples during the 6 months of research of 1.460 µg/kg. Since the European and Kosovo regulations refer to the maximum values of 4 µg/kg beta-lactam antibiotic residues, we can say that the results obtained from the 181 milk samples researched during the January-June period are below these values, which indicates that all values, even the highest of. 2.792 µg/kg, resulting negative in beta-lactam residues. As noted, the willingness of collection points and milk processing factories to carry out the test in milk for residues of beta-lactam antibiotic residues has led farmers to deliver milk without antibiotic residues, either because of their increased awareness of the damage that such waste brings to health, either because of the fear of punitive sanctions. Based on the results obtained during this research as well as on other potentiated factors, we can say that the milk which is accepted at the collection points and milk processing factories in Kosovo, is safe for wide consumption.

**Keywords:** Milk, beta- lactams, antibiotics, residues, results.

## 1. Introduction

If the milk is used for immediate consumption or as a raw material for the production of milk products, it must be organoleptically, physically, chemically, and microbiologically regular and not contain any harmful prohibited substances. [1],[2] Among the many prohibited substances in milk, antibiotic residues are the most common artificial inhibitory substances in cow's milk with a negative impact on human health, processing, and quality of the milk. [3] Antibiotic residues in milk can be a concern, as they may result from the use of antibiotics in dairy farming to treat and prevent diseases in cows. Farmers are required to adhere to withdrawal periods, which are specific waiting periods after administering antibiotics to dairy cows. During this time, the cow's milk is not collected for human consumption to allow the antibiotics to be metabolized and eliminated from the cow's system. This practice helps minimize the risk of antibiotic residues in milk. The presence of antibiotics in milk can pose several risks and challenges to the dairy industry. These risks can affect the industry's reputation, economic sustainability, and public health. The detection of antibiotic residues in milk also can lead to financial losses for dairy farmers and processors. When antibiotic-contaminated milk is identified, it may need to be discarded, resulting in economic losses for the producer. [4] The presence of antibiotic residues can damage the reputation of both dairy farms and the dairy industry as a whole. Consumers may lose trust in dairy products if they perceive that antibiotics are being used irresponsibly or if they believe that milk may contain antibiotic residues. [5] Antibiotic residues in milk can raise concerns about the potential health effects on consumers, including allergies and the development of antibiotic resistance. Public perception of the safety and quality of dairy products can be negatively impacted when antibiotic residues are detected. [6] Repeated instances of antibiotic residues in milk can erode consumer confidence in dairy products. This loss of trust can have long-term consequences for the industry's market share and profitability. [7]

The presence of antibiotics in milk can pose various risks to human health. When antibiotic residues are present in milk consumed by humans, it can have several adverse effects on health, including potential allergic reactions, because the consumption of milk containing antibiotic residues can trigger allergic reactions in sensitive individuals. [8] The presence of antibiotic residues in milk can contribute to the development of antibiotic resistance in bacteria, including those in the human gut. This can make it more challenging to treat bacterial infections with antibiotics in the future. [9], [10] In some cases, exposure to antibiotic residues in milk may lead to toxic effects or side effects in individuals, depending on the specific antibiotic and its concentration in the milk. [11]. Consumption of milk with antibiotic residues can disrupt the balance of the gut microbiome, potentially leading to digestive issues and other health concerns.[12]

It's important to note that rigorous monitoring and testing programs, along with strict regulations, are in place to minimize the risk of antibiotic residues in milk and to ensure that milk and dairy products on the market are safe for human consumption. Dairy producers are required to follow withdrawal periods and other best practices to prevent antibiotic residues from entering the milk supply.

Beta-lactam antibiotics are a class of antibiotics that contain a beta-lactam ring in their molecular structure. This class includes several important subclasses, such as Penicillins as Amoxicillin, Ampicillin, Penicillin G, Penicillin V, Oxacillin, Methicillin; [13] Cephalosporins as Cephalexin, Ceftriaxone, Cefuroxime, Ceftazidime, Cefixime. [14].; Carbapenems as Imipenem, Meropenem, Doripenem, Ertapenem, [15]. and Monobactams as Aztreonam [16].

The detection of antibiotics in milk is a critical aspect of ensuring food safety and compliance with regulatory standards. Various laboratory methods and techniques are used to detect the presence of antibiotics in milk. One of these methods of analysis with which we have worked during our research is also Enzyme-Linked Immunosorbent Assay (ELISA) which is a sensitive and specific immunological method used for the detection of antibiotics in milk. Antibodies specific to the target antibiotics are used to capture and detect the presence of antibiotics in milk samples.[17] Within this method, we can especially emphasize the Rosa Charm β Lactam test (Charm Sciences). The Charm Rosa Pearl Reader is a laboratory apparatus used for detecting the presence of antibiotics in milk and other dairy products. It utilizes a technology known as the Charm Rosa Pearl System, which is based on the principle of enzyme-linked immunosorbent assay (ELISA).

On the contrary, other methods are also used in practice, such as microbial inhibition assays, such as the Delvotest, which are widely used for screening antibiotic residues in milk. These tests rely on the ability of bacteria (usually Bacillus stearothermophilus) to grow in milk. The presence of antibiotics inhibits bacterial growth, leading to a visible change in the as say. [18]; High-Performance Liquid Chromatography (HPLC) is a widely used technique for the quantification of antibiotics in milk. It involves the separation of individual antibiotics based on their chemical properties and subsequent detection using ultraviolet (UV) or mass spectrometry (MS) detectors. [19].; Liquid Chromatography-Mass Spectrometry (LC-MS) is a highly sensitive and specific method for the identification and quantification of antibiotics in milk. It combines liquid chromatography separation with mass spectrometry detection to provide accurate results. [20].; Gas Chromatography (GC) is used for the detection and quantification of volatile and semi-volatile antibiotics in milk. It involves the separation of antibiotic compounds based on their vaporization properties and subsequent detection by a detector like flame ionization detection [21]. All these methods are commonly used by regulatory agencies, dairy processors, and testing laboratories to ensure the safety and compliance of milk and dairy products concerning antibiotic residues. The choice of method depends on factors such as the type of antibiotics being tested and the required sensitivity and specificity.

The maximum allowable values for antibiotics in milk and dairy products can vary depending on the specific antibiotic and the regulatory standards of the region or country. In the European Union, the regulatory levels or Maximum Residue Limits (EU-MRL) are defined by Regulation (EC) 470/2009 [22] and established by Commission Regulation (EU) 37/2010 [23]. For example, the MRL for Penicillin and Ampicillin in milk is set at 4 µg/kg.[24]. At the same time, the Kosovo Food and Veterinary Agency (KFVA) of the Republic of Kosovo after harmonizing the regulations with those of the EU, through Regulation no.12/2011 laying down specific rules on hygiene of food of animal origin and administrative instruction ma-no. 14/2006 on the determination of the maximum waste limit, also is set at 4 µg/kg for beta-lactams such as Benzilpenicilin, Amoxycilin, and Ampicilin.

## 2. Materials and methods

The research on the presence of beta-lactam antibiotic residues in milk was done during the six months (January – June) 2021, at the milk collection point "Jeta e Re" in the Municipality of Istog, Republic of Kosovo. The research included 181 milk samples where 1 sample represented about 3000 liters of milk from an average of 60 farms per day. Farmers have brought milk to the collection point with different canisters and in quantities from 20 to 200 liters of milk. Before accepting the milk, the milk sample was taken and the alcohol test was done by mixing in petri dish a 2 ml. of 85% alcohol and 2 ml. fresh milk. Only the samples that were negative in the alcohol test were taken and placed in 3 lactofreezes with a capacity of 1000 liters each. A sample for the analysis in the presence of beta-lactams was not taken from each lactofreeze from one sample, but a sample was taken from all three lactofreezes and this was done for economic reasons, to save the costs of the analysis.

**Table 1**. Number of milk samples throughout the months

| Month | January | February | March | April | May | June | Total samples |
|---|---|---|---|---|---|---|---|
| No. of samples | 31 | 28 | 31 | 30 | 31 | 30 | 181 |

The analysis of the presence of beta-lactam antibiotics in the researched samples was carried out through the Charm Rosa Pearl System includes test kits for detecting beta-lactam antibiotics, such as penicillin and ampicillin, in milk. The Charm Rosa Pearl Reader is a laboratory apparatus used for detecting the presence of antibiotics in milk and

other dairy products. It utilizes a technology known as the Charm Rosa Pearl System, which is based on the principle of enzyme-linked immunosorbent assay (ELISA). These methods, based on the use of specific receptors to detect antibiotics, were originally designed for the rapid detection of β-lactam antibiotics in cow milk. These methods, based on the use of specific receptors to detect antibiotics, were originally designed for the rapid detection of β-lactam antibiotics in cow milk.

Test Procedure

The Charm Rosa Pearl Reader test was employed following the manufacturer's instructions. For cows, 300 µL of milk sample was mixed with 300 µL of the dilution buffer (cow milk dilution buffer; Charm Sciences Inc.) and refrigerated for 10 min. Then, 300 µL of the mixture was placed in the sample compartment of the strip placed in the ROSA Incubator (Charm Sciences Inc.). The incubation time was set at 56°C for 8 min and results were interpreted visually and with the ROSA Pearl Reader, Charm Sciences Inc.). The Charm MRL BLTET test uses receptors that bind β-lactam drugs. As milk flows through the test strip, unreacted receptors bind at the BL (β-lactam) position and form a visible reddish test line. A weaker intensity BL line forms when β-lactam drugs are present in the milk sample. Visual interpretation of the results was carried out by comparing the BL lines with the control (C) line. If both lines are darker than or equal to the C line, the milk sample is negative (antibiotic-free). If either the BL line is lighter than the C line or the BL line does not form, the sample is positive (likely antibiotic presence). After the visual inspection of the strips with the milk samples investigated for the presence of beta-lactam antibiotic residues, all the strips are placed in the Charm Rosa Pearl Reader device, observing the four-digit results (values) and marking them in a list which will serve for statistical processing of the results.

## 3. Results and Discussions

**Table 2.** Beta-lactam residue values through Charm Rosa Pearl Reader (µg/kg)

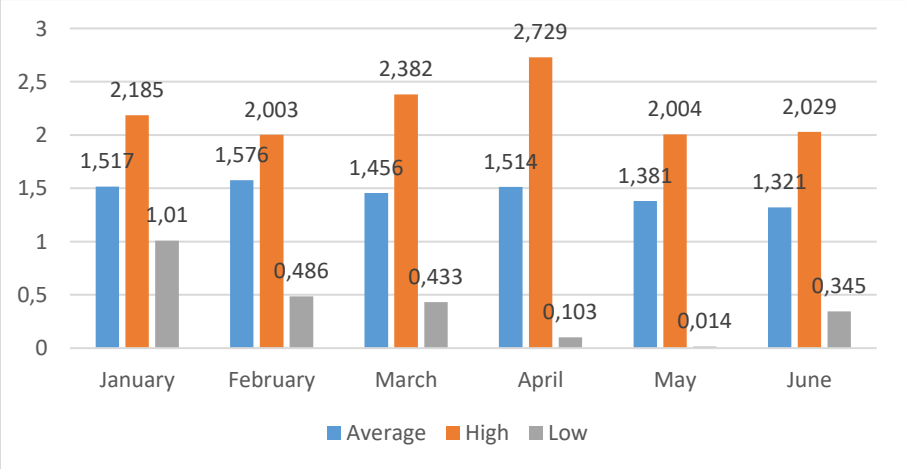
| Date | January | February | March | April | May | June |
|---|---|---|---|---|---|---|
| 1 | 1845 | 1965 | 1432 | 1862 | 2004 | 1845 |
| 2 | 1532 | 2003 | 1739 | 1432 | 1743 | 1463 |
| 3 | 2185 | 1643 | 1423 | 1050 | 1874 | 1352 |
| 4 | 1734 | 1324 | 1744 | 1011 | 1684 | 1141 |
| 5 | 1483 | 1593 | 1812 | 1259 | 1856 | 1061 |
| 6 | 1253 | 1521 | 1719 | 2729 | 873 | 1024 |
| 7 | 1784 | 1358 | 1761 | 103 | 1156 | 1243 |
| 8 | 1035 | 1611 | 1564 | 262 | 1063 | 1563 |
| 9 | 1714 | 1746 | 1495 | 2318 | 1748 | 1849 |
| 10 | 1242 | 1435 | 1322 | 1986 | 1849 | 1560 |
| 11 | 1854 | 1885 | 1270 | 1807 | 1754 | 345 |
| 12 | 1232 | 1939 | 1196 | 1649 | 1104 | 474 |
| 13 | 1645 | 486 | 1694 | 1886 | 14 | 481 |
| 14 | 1789 | 1358 | 1169 | 1720 | 1335 | 1325 |
| 15 | 1243 | 1342 | 1382 | 1880 | 1435 | 1463 |
| 16 | 1325 | 1542 | 2382 | 1657 | 1264 | 1244 |
| 17 | 1653 | 1432 | 1384 | 1677 | 1539 | 1352 |
| 18 | 1712 | 1722 | 1384 | 1368 | 1314 | 1241 |
| 19 | 1805 | 1845 | 1298 | 1246 | 1654 | 1631 |
| 20 | 1922 | 1744 | 1325 | 1617 | 1321 | 1345 |
| 21 | 1705 | 1840 | 1249 | 1125 | 1743 | 1232 |
| 22 | 1453 | 1643 | 854 | 1215 | 1231 | 1649 |
| 23 | 1305 | 1244 | 1734 | 1342 | 1456 | 1114 |
| 24 | 1024 | 1325 | 1442 | 1576 | 1273 | 1956 |
| 25 | 1142 | 1554 | 1347 | 1563 | 1849 | 1214 |
| 26 | 1125 | 1856 | 1325 | 1894 | 453 | 412 |
| 27 | 1654 | 1743 | 1644 | 1873 | 1349 | 2029 |
| 28 | 1010 | 1449 | 1732 | 1568 | 1855 | 1964 |
| 29 | 1233 | | 433 | 1231 | 1439 | 1735 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 30 | 1634 | | 1247 | 1542 | 1947 | 1325 |
| 31 | 1777 | | 1644 | | 432 | |

The values obtained through Charm Rosa Pearl Reader as seen in the table above are 4 digits. However, these values are in ppb (parts per million) or µg/kg. As an example, the value obtained from the sample dated January 1 is 1845, which indicates that the level of beta-lactam residues in this sample is 1.84 µg/kg or 1.845 ppb.

The reflection of the fluctuations of the minimum and maximum values of beta-lactam residues throughout the months are reflected in the following in graph no. 1

**Graph no. 1.** Reflection of fluctuations of minimum and maximum values of residues of beta-lactam antibiotics (µg/kg) in fresh milk throughout the months




Based on the results presented above, we note that the values of residues of beta-lactam antibiotics range from a low value of 0.014 µg/kg in May to a high value of 2.729 µg/kg in April and with the general average for all samples during the 6 months of research of 1.460 µg/kg. The European regulations (European Union, 2009), as well as those of Kosovo (Regulation no.12/2011 and Administrative Instruction ma-no. 14/2006) regarding the highest value of beta-lactam residues in cow's milk, refer to the maximum values of 4 µg/kg then we can say that the results obtained from the 181 milk samples of research during the January-June period are below these values, which indicates that all values, even the highest of. 2.792 µg/kg, based on the above-mentioned regulations, results negative in beta-lactam residues. The results obtained during the 6-month research for the detection of fresh milk for the presence of beta-lactam and antibiotic residues are below the maximum level allowed by regulations that regulate these issues and are considered negative results, respectively the milk delivered to the collection point by farmers do not contain antibiotic residues.

The obtained results indicate the reliability and sensitivity of the Charm Rosa Pearl reader in the detection of beta-lactam residues. This reliability is emphasized in the works of other authors as well. This statement can be justified by the works of many authors. So, M. C. Beltrán, et al. [25]. in their research, to evaluate the Charm MRL BLTET test for the detection of β-lactams and tetracyclines in the milk of small ruminants, an evaluation study was performed at Instituto de Ciencia y Tecnologia Animal of Universitat Politècnica de València (Spain). The test specificity and detection capability (CCβ) were studied following Commission Decision 2002/657/ EC. Specificity results obtained in this study were optimal for individual milk free of antimicrobials from uses (99.2% for β-lactams and 100% for tetracyclines) and goats (97.9% for β-lactams and 100% for tetracyclines). These results are similar to those obtained by Reybroeck et al. [26], using the Charm MRL-3 test to detect β-lactams in cow milk samples, the only exception being cloxacillin, which was also detected by those authors at a concentration below EU-MRL (14 µg/kg). Salter et al. also obtained appropriate sensitivity with the Charm 3 SL3 β-lactam test according to safe level/tolerance as stipulated by the FDA (2005). Also, Salter et al. [27]. indicate a specificity of 100% for raw commingled milk from cows for the Charm 3 SL3 β-Lactam test (Charm Sciences Inc).

The obtained results where we find the absence of detectable beta-lactam residues in all 181 milk samples indicate compliance with regulatory standards. This confirms the safety of the milk concerning beta-lactam residues.

Milk that the farmers deliver to the collection points which then either process this milk or as subcontractors deliver it to larger milk production factories, seems can be considered safe from the presence of residues of beta-lactam antibiotics. The reason for these results is that collection points and milk processing factories strictly and daily

analyze the milk received from farmers for the presence of beta-lactam antibiotic residues. One of the reasons is to avoid damaging dairy products that cannot be processed if bacterial residues are present, such as fermented milk, since the presence of antibiotics would have inhibited normal fermentation processes during yogurt production. The second reason is that they maintain their reputation in tough competition to find the local market in which several competing companies operate.

Considering the reasons why collection points and milk processing factories necessarily carry out the analysis for antibiotic residues, it seems that farmers, knowing this, do not risk delivering milk that they know or suspect contains antibiotic content. This is because if their milk contains residues of beta-lactam antibiotics, then the farmer who has delivered such milk is obliged to pay all the economic damage caused in the event of the milk being discarded. Even in our case, we think that no farmer wants to be punished with the payment of the amount of milk of about 3000 liters.

## 4. Conclusions

The analysis of the presence of residues or beta–lactam antibiotics in the research from 181 fresh milk samples, results in a range from an average value of 1.460 μg/kg which is a lower value than the allowed value of 4.00 μg/kg which indicates that the values obtained are negative in the presence of antibiotic residues (beta-lactams) in milk.

The obtained results indicate the reliability and sensitivity of the Charm Rosa Pearl reader in the detection of beta-lactam residues.

The milk collection points that deliver this milk to the milk processing factories obligatorily and strictly analyze all milk samples for the presence of antibiotic residues (beta-lactam), following the legal regulations that regulate these issues.

Milk that is used as a raw material in the dairy industry in Kosovo and that is collected at collection points can be considered free of antibiotic residues and safe to use for general consumption.

It seems that farmers respect the withdrawal of antibiotics in milk as a result of their increased awareness of the damage that such waste brings to health, either because of the fear of punitive sanctions.

It is necessary to research the presence of antibiotic beta-lactam residues in fresh milk from the farms of farmers who do not deliver milk to collection points or milk processing factories but who sell that milk privately on the market or from that milk they produce milk products that they sell on the market.

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# The effects of hygiene and good manufacturing practices on the quality of fresh milk in some farms in the Gjilan region

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**Abstract.** The research is important because it highlights the deficiencies that milk producers have in implementing proper hygiene practices in dairy cow stalls, which have an impact on milk quality. The study was conducted in three Municipalities of the Gjilan region (Vitia, Kamenica and Gjilani), Kosovo. Data were collected during April-May 2021 for the years 2019 and 2020. A structured questionnaire was used to collect all information related to milk quality. The questionnaire was designed to capture information related to general farm characteristics, number of dairy cows, use of mastitis tests, presence of lactofreezes for milk, pre-milking udder hygiene practices, udder disinfection and use of cleaning wipes etc. Out of 71 farms surveyed, 47 of them or 66.2% reported that they did not have lactofreezes for milk cooling, while only 24 farms or 33.8% had lactofreezes for milk cooling. Farms with lactofreeze, on average, have more experience (18.87 years), while those without lactofreeze have less experience (14.7 years). The surveyed farms, based on milk quality, were: 16.9% or 12 farms of extra class, 29.6% or 21 farms in the first class and 4.2% or 3 farms in the 2nd class, while 35 farms were below the quality standards. 84.5% or 60 farms clean the cow's udder with warm water, while 15.5% or 11 farms with cold water. 48 farms use the same wiping cloth for two or more cows. 32.4% or 23 farms were controlling mastitis. To assess the effects of udder disinfection in relation to milk quality, half of the farms fall below the national minimum standard. We recommend the relevant institutions, local and central, to encourage farms to improve quality by offering them technical and financial support through associations, advisory services and other interested parties.

**Keywords:** hygiene, good production practices, milk quality, farm.

## 1. Introduction

According to (MBPZHR, 2022) [1], the number of farms with 5 or more dairy cows at the state level is 9163, while in the researched municipalities of Gjilan, Kamenica, and Viti, there are 845 potential farms [2]. (AZHB, 2022) [2] 1374 farms at the state level have benefited from milk quality based on approved criteria in the 2006, extra class, classes 1 and 2. However, of the 845 potential farms only 95 farms or 11.24% met the quality standards according to the administrative directive and received state incentives for milk quality improvement. In the study by (Pavičić et al., 2008) [3], the impact of udder hygiene on the quality of raw milk from cows is discussed. Improved udder hygiene, including pre and post-milking udder disinfection, significantly reduced the average number of somatic cells and microorganisms in raw milk, thus enhancing milk hygiene and quality for a specific time period. In another study by (De Silva et al., 2015) [4], the microbiological quality of raw milk and its improvement through best management practices in Sri Lanka is explored. After implementing good management practices, the standard plate counts of cooling centers improved, indicating lower microbial counts in the milk The Kosovo Dairy Producers Association [5] provides a manual for improving milk quality and good practices before milking. The main aim is to reduce bacterial counts on the udder before attaching the milking machine. Teats must be cleaned and dry, and the milking machine should not be placed on a wet or inadequately cleaned udder to prevent bacterial growth and mastitis. (Mergim Mestani and Almir Abdurramani, 2016) [6] emphasize hygienic conditions in animal husbandry. Proper hand and equipment washing, as well as udder hygiene practices, directly influence the microbial load in the milk. The udder should undergo special cleaning and disinfection before each milking. Disinfection is crucial, especially when performed after washing. Common disinfectants include iodophors and hypochlorites. (Merkez and Ahmed, Bagcilar) [7] discuss the system of good production practices in Istanbul, Turkey. This system ensures that products adhere to standards throughout all production processes, including input material handling, production, packaging, storage, and distribution, with a focus on product quality. In modern times, the fields in which the system of best practices for PMP (Proper Milk Production) is applied have significantly expanded. For

instance, ISO 9001 Quality Management System, 14001 Environmental Management System ISO, HACCP (Hazard Analysis Critical Control Point) System, 22000 Food Management System ISO, OHSAS 18001, etc. (G.M. Jones, 2006) [8]. All equipment, lines, and surfaces of milk vessels that come into contact with milk, from impurities to organic residues, must be thoroughly cleaned and disinfected before the next milking. The purpose of cleaning is to remove milk deposits, solid organic and mineral substances that form on the equipment surfaces after milk removal. The purpose of disinfection is to eliminate any remaining microorganisms present on these surfaces immediately before milking. (Gelane Kumssa, 2018) [9]. The effect of the milk processing procedure and treatment on its quality at the Haramaya University Dairy Farm in Addis Ababa, Ethiopia, observed that the percentage of producers who used separate towels for each cow was only 3.8%. The average overall bacterial count of raw milk produced on the farm was 6.65 log cfu/ml. This value was higher than the acceptable value of 1 x 105 bacteria per ml of raw milk. The high level of milk contamination was due to interior contamination, water quality, cleaning, and milking utensils. Mastitis is, along with fertility disorders and lameness (Mitev et al., 2011; Varlyakov et al., 2012),( [10 and 11] the most common diseases of dairy production and a significant source of economic losses. Mastitis leads to increased somatic cell counts in milk, which affects its quality. High somatic cell counts can result in decreased milk production, altered composition (such as reduced protein and lactose content), and compromised shelf life which affects the decrease in profitability. (Hogeveen et al, 2011). [12]. Subclinical mastitis increases the susceptibility of cows to clinical mastitis, which is characterized by visible signs of inflammation and illness. Persistent subclinical infections can progress to clinical mastitis episodes, further impacting cow health and milk production. (Schukken et al,2011).[13] This means that the decrease in milk quality affects the decrease in profitability because the production of milk is reduced kg per cow per lactation (Kvapilik et al, 2014). [14]. Economic losses per case of clinical mastitis can be direct costs which include diagnostics, therapeutics, non-saleable milk, veterinary service, labor and death loss and indirect costs which included future milk production loss, premature culling and replacement loss and future reproductive loss. (E. Rollin et al, 2015).[15]. (Zeqiri M. et al., 2015), In studies Dairy Farmers Awareness about Food Safety Standards - the case of Kosovo Answer to the question: “Do you have cooling tank?” In the 150 case farms researched in the region of Gjilan and Ferizaj, only 20 farms or 13.3% had lactofreezes, while 130 farms or 86.7% of them did not have lactofreezes at all, all of these farms were directed to the market of the milk. [16].

## 2. Materials and methods

The study was conducted in the three municipalities of the Gjilan region (Viti, Kamenica, and Gjilan) in Kosovo. The data was collected during the months of April-May 2021 for the years 2019 and 2020. A structured questionnaire was used to gather all information related to milk quality. To avoid confusing questions and ensure clarity, the questionnaire was pre-tested with 5 farmers. A total of 71 face-to-face interviews were conducted, and the farms were randomly selected from the respective municipalities' lists of farmers. 5-78 dairy cows are cultivated on each of the visited and interviewed farms. Interviewers did not encounter any significant problems regarding participation willingness, as they were informed about the purpose of the interview and survey. The questionnaire was created to capture information regarding the general characteristics of the farm, the number of dairy cows, the use of mastitis testing, the possession of milking machines, udder pre-milking cleaning, udder disinfection, the use of tea cups for cleaning, etc.

## 3. Results and Discussions

Hygiene and good production practices have a big role in the quality of fresh milk, which also depends on the quality of the first product, whether as milk for consumption or for its products in the food industry. To see some of the good practices and milk hygiene, the following tables are also presented for: the number of cows in the researched farms, milk freezers, milk classes in which the farms are located, experience, cleaning of milk equipment and machines, cleaning of the cow's udder, disinfection and tests for mastitis.

**Table 2.** Descriptive statistics for farms

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Milk cows 2019 | 71 | 5.0 | 70.0 | 13.761 | 10.9329 |
| Milk Cows 2020 | 71 | 4.0 | 78.0 | 12.887 | 10.6698 |
| Valid N (listwise) | 71 | | | | |

In 2019, a farmer had an average of nearly 14 cows, while in 2020 about 13 cows. The minimum value of the number of cows on the farm for 2019 was 5 heads, while for 2020 the minimum value for the head of cows on the farm was 4 heads. The maximum number of cows per head for 2019 was 70, while for 2020 it was 78 heads. The standard deviation is 10.93 for the 2019 cow, while for 2020 it was 10.66.

**Table: 2.** Do you have a milk cooler?

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Vlid | 24 | 33.3 | 33.8 | 33.8 |
| 1.0 | 47 | 65.3 | 66.2 | 100.0 |
| 2.0 | 71 | 98.6 | 100.0 | |
| Total | | | | |

* (1.0) farms that have a cooling tank for milk
* (2.0) farms that do not have cooling tank for milk
* (71) Number of farms in the research

Column (2.0), 66.2% or 47 farms did not have cooling tank for milk, while 33.8% or 24 farms had cooling tank for milk (1.0) columns.

**Table: 3.** In which class of milk are you according to quality (classification of milk according to national guidelines)

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Valid | 1.0 | 21 | 29.2 | 29.6 |
| | 2.0 | 3 | 4.2 | 4.2 |
| | 3.0 | 1 | 1.4 | 1.4 |
| | 4.0 | 12 | 16.7 | 16.9 |
| | 5.0 | 34 | 47.2 | 47.9 |
| | Total | 71 | 98.6 | 100.0 |

* (1.0) first class
* (2.0) second class
* (3.0) third grade
* (4.0) extra classes
* (5.0) They don't know the class of milk

Regarding the milk class, 47.9% (34 farmers) declared that they do not know what class they are in, 16.9% or 12 farms are in the extra class, 29.6% or 21 farms in the first class, 4.2% or 3 farms in class 2 and 1.4% or 1 farmer in class 3.

**Table: 4.** Group Stats experience on farms vs owning a cool tank

| | Lactofreeze | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Cow Experience | 1.0 | 23 | 18.87 | 12.843 | 2.678 |
| Cow Experience | 2.0 | 47 | 14.72 | 11.300 | 1.648 |
| Missing | System | 1 | 1.4 | | |
| Total | 72 | 100.0 | | | |

* valid 70 farms
* (1.0) experience in farms for more than 15 years
* (2.0) farm experience of less than 15 years

Farmers who have cooling tank, on average, have more experience (18.87 years), while those who do not have a tank (14.7 years). For the "farm experience" factor, there are two categories: 1.0 (indicating experience more than 15 years) and 2.0 (indicating experience less than or equal to 15 years). In the category of experience in farms greater than 15 years (1.0), there are 23 observations (N). The average (mean) farm experience for this group is 18.87 years, with a standard deviation of 12.843 years and a mean standard error of 2.678 years. In the category of farm experience less than or equal to 15 years (2.0), there are 47 observations (N). The average farm experience for this group is 14.72 years, with a standard deviation of 11,300 years and a mean standard error of 1,648 years.

**Table: 5.** Do you clean the milking machines and at what intervals?

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Valid 1.0 | 27 | 37.5 | 38.0 | 38.0 |
| 2.0 | 39 | 54.2 | 54.9 | 93 |
| 3.0 | 4 | 5.6 | 5.6 | 98.6 |
| 4.0 | 1 | 1.4 | 1.4 | 100.0 |
| Total | 71 | 98.6 | 100.0 | |

| | | | | |
|---|---|---|---|---|
| Missing System | 1 | 1.4 | | |
| Total | 72 | 100.0 | | |

*valid 71 farms

**Table: 6.** Do you clean the cow's udder before milking and what water do you use?

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Valid 1.0 | 60 | 83.3 | 84.5 | 84.5 |
| 2.0 | 11 | 15.3 | 15.5 | 100.0 |
| Total | 71 | 98.6 | 100.0 | |
| Missing System | 1 | 1.4 | | |
| Total | 72 | 100.0 | | |

*valid 71 farms
* (1.0) hot water
* (2.0) cold water

From the table we see that 84.5% or 60 farms clean the cow's udder with warm water, while the rest 15.5% or 11 farms clean the udder with cold water.

**Table :7** Do you use cleaning cloths to wipe the cow's udders?

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Valid 1.0 | 4 | 5.6 | 5.6 | 5.6 |
| 2.0 | 22 | 30.6 | 31.0 | 36.6 |
| 3.0 | 17 | 23.6 | 23.9 | 60.6 |
| 4.0 | 23 | 31.9 | 32.4 | 93.0 |
| 5.0 | 5 | 6.9 | 7.0 | |
| | 71 | 98.6 | | |
| Total | | | 100.0 | 100.0 |

* (1.0) cloth for 2 or more cows
* (2.0) did not use cloth at all
* (3.0) cloth for one or two cows
* (4.0) separate cloth for each cow
* (5.0) cloth for the whole farm

5.6% or 4 farms used one cloth for two or more option cows (1.0), 31% or 22 farms did not use (2.0), 23.9% or 17 farms used it for every two option cows (3.0), 32.4% or 23 farms used a separate cloth for each cow (4.0) and 7% or 5 farms used the only cloth for the whole farm.

**Table :8** Do you test for mastitis on your farm?

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Valid 1.0 | 9 | 12.7 | 12.7 | 12.7 |
| 2.0 | 62 | 87.3 | 87.3 | 87.3 |
| Total | 71 | 100.0 | 100.0 | 100.0 |

* (1.0) farms that test for mastitis
* (2.0) farms that do not test for mastitis

From the above table we can see that 87.3% of farmers have declared that they do not control mastitis or in total 62 farms out of a total of 71 researched option (2.0) and 12.7% or 9 farms had done mastitis control in their option farms (1.0).

**Table :9** Do you disinfect the cow's udder before and after milking

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Valid 1.0 | 16 | 22.5 | 22.5 | 22.5 |
| 2.0 | 10 | 14.1 | 14.1 | 36.6 |
| 3.0 | 25 | 35.1 | 35.1 | 71.8 |
| 4.0 | 20 | 28.2 | 28.2 | 100.0 |
| Total | 71 | 100.0 | 100.0 | |

* (1.0) disinfection before milking
* (2.0) disinfection before and after milking
* (3.0) disinfection after milking
* (4.0) disinfection is not done at all

From the above table we see that 22.5% or 16 farms disinfect udders before milking, 14.1% or 10 farms disinfect the udder before and after milking, 35.2% or 25 farms declare that they disinfect the udder only after milking, while 28.2% or 20 farms do not perform disinfection at all.

## 4. Conclusion

It is research that aims to highlight some of the best practices in milk production following the milk hygiene protocol in some randomly selected farms in the Gjilan region. Descriptive statistics for the number of dairy cows on farms (Table 1) show that in 2019, a farmer had an average of about 14 cows, while in 2020, about 13 cows, indicating a decrease in the number of cows in 2020. two variables had 71 observations with minimum values of the number of cows on farms for 2019, 5 cows per farm, and for 2020, the minimum value of cows per farm was 4, heads.

The maximum number of cows per farm for 2019 was 70, while for 2020 it was 78 cows. The standard deviation was 10.93 for cows in 2019 and for 2020 it was 10.66.

The question of whether you have a cooling tank (Table 2), to better understand how many of the farms surveyed perform milk cooling according to standards and best practices, out of 71 farms surveyed, 47 of them or 66.2% reported that they do not this.

while only 24 farms or 33.8% have milk coolers and do milk cooling. This shows that more than half of the farms (Table 3) are not yet equipped with milk coolers and do not perform milk cooling according to production standards, reflecting a relatively high number of farms that do not know what class of milk they are, or 37 farms or 47.9% of the 71 farms under study. In 2015, out of 150 farms surveyed, 86.7% or only 20 farms had lactofreeze, which shows a very small increase for 2019 and 2020. [16].

Comparing the impact of experience (Table 4) in relation to milk coolers (Table 2), we note that farmers who have milk coolers, on average, have more experience (18.87 years) with a standard deviation of 12.84, while non-coolies have a mean of 14.7 years of experience, with a standard deviation of 12.84 years and a standard error of 2.67 years.

To observe the ranking of dairy farms based on quality (Table: 3) and in which class of milk quality compared to the question of whether you clean milk machines (table 5), we have: 16.9% or 12 farms of the class above good or extra, 29.6% or 21 farms in the first class and 4.2% or 3 farms in the 2nd class, while 35 farms fall below the quality standards, which shows that the hygienic process of cleaning the milk machine has affected almost 50% of farms to meet milk production standards according to quality.

To observe the effect of udder cleaning (table 6) on milk quality before and after milking in relation to the ranked milk quality classes (table 3), out of 71 farms, 84.5% or 60 farms clean the udder with warm water, while 15.5% or 11 farms use cold water for cleaning the bay. This resulted in 35 farms, or half of those in the study, falling below the quality standard, suggesting that udder drying may not have been done properly in the process.

To observe the effect of using towels for wiping or drying the cow's udder (Table: 7) in relation to the ranked milk quality classes (Table 3), it turns out that half of the surveyed producers, or 35 farms, are under the standard. This is due to the fact that only 32.4% or 23 farms out of 71 surveyed use separate towels for each cow, while other farms lack this hygienic measure. This may be one of the reasons why half of the farms do not meet the standards for the quality of milk production.

To observe the effects of mastitis control and tests (Table 8), tests are carried out in relation to milk quality classes (Table 3), revealing that half of the investigated producers, or 35 farms, do not meet the quality standards.

When we evaluate the impacts of udder disinfection on cows (Table 9) in relation to milk quality (Table 3), we find once again that about half of the farms are below the minimum national standard in relation to milk quality, which amounts to 50 %, or 35 farms under study. This may be due to the fact that udder disinfection before and after milking is implemented by only 14.1% or 10 farms out of all surveyed farms, while the remaining 61 farms implement it partially or not at all (Table 9).

We recommend dairy producers follow a hygienic protocol including cleaning the cow's udder, drying it, disinfecting the udder, testing for mastitis, cleaning and disinfecting milking machines and equipment in contact with the milk, and cooling the milk. The goal is to ensure the production of high quality milk.

We advise milk producers to be equipped with cooling tanks for optimal storage and quality maintenance of raw milk. We suggest that milk producers apply hygiene and best production practices.

We recommend that milk producers attend trainings related to hygienic measures and the protocol of good manufacturing practices.

We recommend the relevant institutions, such as the local and central ones, to promote the farms more in quality by supporting them even more in the technical and financial aspects through associations, advisory services and other actors.

Acknowlwdgment

The authors thankfully acknowledge farmers with cooperation.

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# Analysis of some microbiological and physicochemical parameters of water as a raw material for the production of non-alcoholic beverages

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**Abstract.** One of the main ingredients of soft drinks is water, which makes up about 86%-94% of the volume of drinks. Soft drink manufacturers face unique challenges in the field of water treatment. Water sources, water treatment processes and treatment wastes can affect the quality and (microbiological) safety of the final product. The aim of this paper is to analyse some qualitative and bacteriological safety parameters of untreated and treated water in one of the non-alcoholic beverage production industries in our country. Water samples were taken at the water plant before treatment, and after treatment, where the following physical and chemical parameters were analysed: pH scale, electrical conductivity, water hardness, residual chlorine, and some bacteriological parameters were also analysed, such as total bacteria and E. Coli. The obtained results of the physical, chemical, and bacteriological analyses are compared with the standards of waters intended as auxiliary raw material in the production process of non-alcoholic beverages.

**Keywords:** water, analysis, physical, chemical, bacteriological, standards.

## 1. Introduction

Water quality is a term used to describe the chemical, physical, and biological characteristics of water. The chemical constituents of water are substances that dissolve in water, including gases (e.g., oxygen and carbon dioxide), metals (e.g., iron and lead), nutrients (e.g., nitrogen and phosphorus), pesticides (e.g., atrazine and endosulfan), and other organic compounds (e.g., polychlorinated biphenyls). The most common physical characteristics of water are color, odor, temperature, taste, and turbidity, while biological constituents of water are living organisms including bacteria (e.g., Escherichia coli), viruses, protozoans (e.g., Cryptosporidiosis), phytoplankton (i.e., microscopic algae) [1]. Water, as the main component of a soft drink, usually accounts for between 85% and 95% of the product and acts as a carrier for the other ingredients [2]. The water used is normally separately pretreated to remove impurities, microorganisms, and other undesirable attributes, such as off-tastes, odors, and turbidity. It is also treated to regulate alkalinity and hardness [3]. Water should comply with the following quality requirements. It should be free from: high levels of elements and mineral salts; objectionable tastes and odours; organic material. It should also be clear and colourless; free from dissolved oxygen; sterile, that is, free from micro-organisms [2]. The constituents in water can have a profound impact on the overall quality and shelf life of beverage products. For example, if alkalinity is not controlled, the acidic profile of the beverage formulas will be compromised, making the beverage more susceptible to microbial growth and spoilage [4].

The major considerations for the design of the system that will result in high-quality treated water at the lowest possible cost for the final beverage are as follows:

The quality of the raw water

The treatment process for microorganisms

The treatment process for removal of or reduction in suspended and dissolved materials

The treatment process to eliminate off-tastes and off-odours

The treatment to ensure high-quality product appearance

The overall effective treatment for all water used in all the company's product types [3].

## 2. Materials and methods

During this research, several water samples were analysed, which were taken at the water treatment plant in one of

the factories producing non-alcoholic beverages in the Republic of Kosovo. In the water treatment plant, where we carried out the research, the untreated water goes through several stages, such as potassium permanganate, sediment filtration, filter media for removing iron, manganese, and hydrogen sulphide from water, chlorination, active carbon filters, reverse osmosis, bacteriological filters, UV-lamps. Microbiological water samples were taken at the water plant before treatment (natural water) and final water (treated) where the following microbiological parameters were analysed: total number of bacteria and E. Coli. Also, in the water treatment plant, several samples were taken, of untreated water (natural water) and treated water (final water), where the following parameters were analysed: pH level, electrical conductivity, water hardness, and residual chlorine.

The methods used to analyse some microbiological water samples are standard methods used in the factory's accredited microbiological laboratory. For the determination of the total number of bacteria, the nutrient medium Plate count agar (PCA) was used, while for the determination of Escherichia Coli, the nutrient medium was used: Endo Agar (EA). We planted the water samples in petri dishes, where we took 3-4 mL of the sample and then we placed the corresponding nutrient grounds. After the nutrient grounds have hardened, we have placed them in incubators. We placed the samples for determining the total number of bacteria in the incubator at a temperature of 37°C, the samples for the determination of Escherichia coli, we also placed them in the incubator at a temperature of 37°C. For the total number of bacteria, the result is read after 24 hours, for Escherichia coli, the result was read after 4 days.

The determination of the pH was done with a digital pH meter, where initially the calibration was done with a standard buffer with pH 4.01, 7.01 and 10, after the calibration the water samples were analysed. The determination of electrical conductivity in water was carried out with a conductometer, where the probe of the conductometer was first rinsed with deionized water, then the water samples were analysed. Determining water hardness: water samples are placed in a 100 mL Erlenmeyer flask, we added a little black Eriochrome indicator and to the same, we added 5 mL buffer with pH 10, where in untreated water (natural water) it turns pink while in the treated water it turns blue when the indicator is added. The sample is titrated with 0.05M EDTA. The spent value of EDTA is multiplied by 2.8. Water hardness is expressed in the German scale °dH. In the treated (final) water, we did a quick test to determine the presence of chlorine in the water. For the quick test we used the special palin pill, where they are placed in a special container and if the water does not change color, it means that there is no presence of chlorine.

## 3. Results and discussion

The results obtained during the following experimental work are presented in tabular form.

Results of microbiological analyses in water

**Table 1.** Results of microbiological analyses in water

| Samples/Parameters | Total number of bacteria | E. Coli |
|---|---|---|
| Before treatment (natural water) | 20 cfu/mL | 0 cfu/mL |
| Final water (treated) | 0 cfu/mL | 0 cfu/mL |

The results obtained and illustrated in Table 1 in the sample, the untreated water: the total number of bacteria 20 cfu/mL, Escherichia Coli 0 cfu/mL, while in the final treated water the total number of bacteria 0 cfu/mL while Escherichia Coli 0 cfu/mL. So, the results show that the technological influences used for water treatment have had a positive effect on reducing the total number of bacteria, the samples for the analysed parameters are safe from the microbiological point of view.

Results of physical and chemical analyses in water

**Table 2.** Results of physical and chemical analyses in water

| Samples/Parameters | pH scale | Electrical conductivity (µS/cm) | Overall hardness (dH°) | Palin Test |
|---|---|---|---|---|
| Before treatment (natural water) | 7.30 | 453 | 12 | Positive |
| Final water (treated) | 6.86 | 70 | 0 | Negative |

In table 2, the results obtained in average values from three measurements for the pH scale resulted with changes, in the untreated water sample the pH value was 7.30, while in the treated water the value was smaller 6.86. The electrical conductivity in the untreated water sample resulted in higher values of 453 (µS/cm) while in the treated water the values were lower 70 (µS/cm), the overall hardness in the untreated water was 12 dH ° while in treated water 0 dH°. The presence of chlorine in the untreated water sample was positive, while the treated water was

negative. So, the application of water treatment processes has had a positive effect according to the values obtained.

## 4. Conclusion

Based on the results of this study we can conclude that:

Untreated water resulted in the highest content of total bacteria count at 20 cfu/mL.

In untreated water and treated (final) water, Escherichia coli resulted with a value of 0 cfu/mL, so the water is considered safe for the analyzed parameter.

The electrical conductivity in the untreated water sample resulted in higher values of 453 (µS/cm), while in the treated water the values were lower, 70 (µS/cm).

The overall hardness in the untreated water was 12 dH° while in the treated water it was 0 dH°.

The average value from the three measurements for the pH scale resulted in changes, in the untreated water sample the pH value was 7.30, while in the treated water the value was smaller 6.86.

The presence of chlorine in the untreated water sample was positive, while the treated water was negative.

The application of water treatment processes has had a positive effect according to the values obtained.

From the results obtained, the treated water is suitable for use in non-alcoholic beverages, cleaning production lines, and other applications.

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# Detection of dimethyl decarbonate in multi-fruit juice pet pack with Velcorin (DMDC) indicator paper

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**Abstract.** One of the problems with microbiological contamination in the non-alcoholic beverage production industry occurs during the filling of liquids into Polyethylene terephthalate (PET) bottles. Even if all strict rules have been implemented during the production of non-alcoholic beverages, after the pasteurization of these beverages, one of the main problems remains the filling of liquids into PET bottles. This issue arises because microorganisms are found everywhere in the ambient air and on bottle caps. For this reason, Dimethyl dicarbonate (DMDC) is approved for use in a wide range of non-alcoholic beverages. Dimethyl dicarbonate is injected after the pasteurization of the juice and before the process of filling the juice and closing the bottle. The aim of this paper is the detection of Dimethyl-dicarbonate during the injection of DMDC, and the detection of DMDC in the final product at different hours to see if DMDC has remained in the liquid or has been completely hydrolyzed. We performed the DMDC detection test with Velcorin indicator paper.

**Keywords:** Dimethyl dicarbonate, Velcorin indicator paper, multi-fruit juice, PET

## 1. Introduction

Microorganisms capable of spoiling beverages, including yeasts, molds, and bacteria, not only compromise the quality and specifically the organoleptic properties of the drink but may also pose health risks to consumers under certain conditions. Velcorin® (Dimethyl dicarbonate or DMDC) has proven to be exceptionally effective in low dosages against these typical spoilage microorganisms. It preserves the quality of the beverages without altering their taste or color. [1].

DMDC is widely utilized as an antimicrobial agent against a broad spectrum of microorganisms. Its antimicrobial efficacy stems from the deactivation of microbial enzymes, primarily through its reaction with protein imidazole and amine groups, ultimately resulting in the microorganisms' destruction (see Figure 1). The remaining unreacted DMDC breaks down rapidly into methanol and carbon dioxide. The DMDC activity is based on the hydrolysis rate. Hydrolysis occurs when DMDC reacts with water and the rate is dependent on the temperature of the beverage [2].

In the production of soft drinks, microbial contamination is a crucial factor influencing sensory characteristics and is also a health risk for consumers. As alternative to the hot fill process is cold filling with DMDC added to control microorganisms during the production process. It deactivates the enzymes, destroying the microorganism while in the beverage it rapidly breaks down into negligible amount of methanol and carbon dioxide [3]. Prominent bodies, such as the EU Scientific Committee on Food, the FDA in the United States and the JECFA of the WHO, have all confirmed that Dimethyl-decarbonate is safe for use in the beverage industry [1].

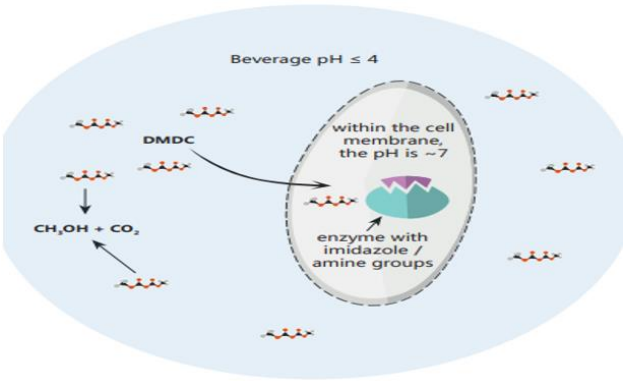


**Figure 1.** The effect of DMDC on the cell membrane

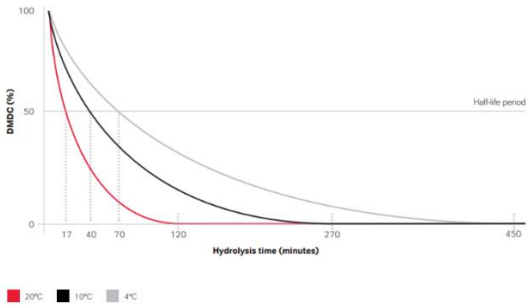


**Figure 2**. Breakdown (hydrolysis) of DMDC in beverages

**Figure 3.** DMDC dosing machine

## 2. Materials and methods

During this research, four samples of multi-fruit juices in PET packaging treated with dimethyl dicarbonate were analyzed. These samples were obtained from a non-alcoholic beverage production facility in the Republic of Kosovo. To detect the presence of dimethyl dicarbonate, samples were collected after DMDC injection into the multi-fruit juice before bottling, as well as from the final packaged multi-fruit juice product in PET bottles. Velcorin indicator paper was utilized for the detection of DMDC. If dimethyl dicarbonate is present in the liquid, the Velcorin indicator paper turns orange. Conversely, if DMDC is absent from the liquid, the indicator paper turns yellow.


**Figure 3.** Velcorin indicator paper

## 3. Results and Discussion

The results acquired from the experimental work conducted are tabulated and presented herein.

Rapid test results for DMDC

**Table 1.** Rapid test results for DMDC

| Sample/Time | After injection |
|---|---|
| Multi fruit juice (treated with DMDC) | Present |

**Table 2.** Rapid test results for DMDC

| Sample/Time | 4 hours after injection |
|---|---|
| Multi fruit juice (treated with DMDC) | Present |

**Table 3.** Rapid test results for DMDC

| Sample/time | 8 hours after injection |
|---|---|
| Multi fruit juice (treated with DMDC) | Not Present |

**Table 4.** Rapid test results for DMDC

| Sample/Time | 12 hours after injection |
|---|---|
| Multi fruit juice (treated with DMDC) | Not Present |

The results obtained, as depicted in Tables 1, 2, 3, and 4, demonstrate that DMDC remains present in the multi-fruit juice samples immediately after injection and at the 4-hour mark. However, the compound is not detectable at the 8- and 12-hour intervals. This indicates that DMDC exerts its preservative effects within the initial 4 hours, and is then completely hydrolyzed into methanol and carbon dioxide, which are natural constituents of the juice, by the 8-hour mark

## 4. Conclusion

Based on the results of this study, the following conclusions can be drawn:

Dimethyl dicarbonate is detected in the multi-fruit juice at the time of injection, indicating that the DMDC injection process into the multi-fruit juice is being executed correctly.

Dimethyl dicarbonate remains present in the liquid even after 4 hours, effectively performing its preservative role.

After 8 hours, dimethyl dicarbonate has fulfilled its preservative function and is no longer present in the multi-fruit juice; it has broken down into methanol and carbon dioxide, substances naturally found in the juice.

For quality assurance, multi-fruit juice should not be consumed or sold within 8 hours of production; instead, it should be stored appropriately in a warehouse.

To ensure safety, multi-fruit juice treated with dimethyl dicarbonate should not be marketed within 24 hours following its production. The juice is considered ready for consumption after this period.

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# Consumer Perception and the Environmental Impact of Fast-Food Packaging

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**Abstract.** Fast food packaging represents a pervasive yet often overlooked facet of modern dining, bearing both convenience and significant environmental challenges. This study investigates how consumer awareness of the environmental consequences of packaging materials influences their preferences and behaviors. It explores consumer preferences for materials perceived as more eco-friendly, such as paper-based options over plastics, and the consequential impact on disposal practices. This study used quantitative research to investigate consumer perception and the environmental impact of fast-food packaging. It was conducted through a Google Docs survey, to which approximately 250 people responded in Kosovo. The data tool used to analyze the answers from respondents is the IBM SPSS program, through which the statistical and graphic data for the choices in the questionnaire are obtained. Understanding the nexus of consumer perception and the environmental impact of fast-food packaging is instrumental in promoting sustainability within the food service industry. The result indicates that environmental awareness among consumers is increasing, they are showing increased interest in products that have less impact on the environment. Also, this research provides valuable insights for policymakers, fast food businesses, and environmental advocates working to align the industry with consumer expectations and broader sustainability goals.

**Keywords:** Consumer Perception, Fast Food Packaging, Environmental Impact, Sustainability

## 1. Introduction

Food product packaging is used to keep, store and protect foods from environment factors and promotion purposes (COLES, 2003) (Raheem, Ahmad, Vinshu & Imamuddin, 2014). But also, it is well known about the impact of packaging on the environment and human health (FootPrint, 2024), which necessitating ongoing monitoring. In today's global landscape, the relationship between consumer perception and the environmental impact of fast-food packaging has emerged as a subject of profound significance. This relationship warrants careful consideration, as understanding it could play a pivotal role in mitigating environmental pollution.

The US Environmental Protection Agency (EPA) states that nearly half of the municipal solid waste is comprised of food and materials used for food packaging, of which the biggest polluters are plastic packaging. Plastic pollution is a serious concern. The Plastic Pollution Coalition (Webinar, 2024) estimates that by the year 2050, the oceans will contain more plastic than fish in terms of weight. The exponential growth of plastics is now threatening the survival of our planet Plastic types of packaging take hundreds of years to break down in our environment and can harm wildlife and their habitats (Goforgreen, 2023). Khwaldia and colleagues (Khwaldia, 2010) highlight that paper is often favored by the food industry due to its eco-friendly reputation, making it a preferred material for packaging. It is extensively utilized both at the primary level, meaning it comes directly into contact with food items, and at the secondary level, which involves the transport and storage of these primary packages. Specifically, paper and paperboard are employed in the production of various food containers, including ice cream cups, microwave popcorn bags, baking paper, milk cartons, fast food boxes like those for pizza, and cups for beverages. However, from a health perspective, when paper comes into direct contact with food, there is a risk of certain chemicals used in the production of grease-resistant paper, such as fluorochemicals, perfluorooctanoic acids (PFOA), and perfluoro-octane-sulfonates (PFOS) (Begley, 2007; Xenia Trier, 2017; You, 2023), migrating from the paper to the food. Additionally, some inks used to print logos and other information on paper packaging may contain heavy metals or other harmful substances that could migrate into the food and some heavy metals involved in paper recycling processes including lead, cadmium, and mercury.

Nowadays in worldwide, increased awareness and behavioral changes regarding fast food packaging are becoming increasingly crucial in the development of sustainable consumption patterns. As environmental awareness grows, consumers are more and more involved in selecting products that reflect their values for a more sustainable world. However, the understanding of eco-friendly packaging among consumers is not always clear and consumers have different motives for choosing green-packaged products (Labrecque, 2021).

A recent study (Conference, 2021) presented at a 2021 conference shows that over a third of consumers worldwide are prepared to spend more on sustainable options, highlighting a rising demand for eco-friendly alternatives.

As environmental concerns and sustainability awareness continue to gain momentum, the choices consumers make regarding their fast-food packaging preferences carry far-reaching implications for the well-being of our planet. If a customer perceives high value, then this affects purchase intention (James, 2002; Ahmed, 2014). As outlined by James (2002), a heightened level of perceived value directly contributes to the intention to purchase.

The purpose of our study is to show the impact of fast-food packaging on the environment and consumer perception. This enables us to find a way to change the consumer's purchase decision by informing them with eco-friendly or biodegradable material, ecological signs, labeling, attractive packaging, promotions and other ways to reduce the impact of packaging on the environment (Yaputra et al, 2022; Estiri, 2010; Technologies, 2023. The findings of research (Prianjana Roy, 2021) suggest that the customer's buying decision might be altered or impacted by developing the packaging and understanding the buying decision of the customers. As fast-food package waste is a growing concern for both businesses and consumers, according to Goforgreen (2023) (fig.).


**Fig.** Package waste from Fast-foods in a late dinner, a – purchase for 1 person and b. waste from 3 purchase persons

Restaurants can enhance the ecological aspects of their fast-food packaging by opting for recyclable and compostable materials instead of traditional plastic or foam containers. Paper packaging is a more environmentally friendly option, and it is easier to recycle than plastic packaging. EU restrictions on certain single-use plastics have influenced the points of sale to take measures to replace them with more environmentally friendly materials (EU Commission, 2021; Guardian, 2023; News, 2023).

Consumers are becoming increasingly environmentally conscious, prompting significant changes in the fast-food industry. This shift is evident through the demand for recyclable and biodegradable packaging materials, which consumers prefer due to their eco-friendly properties. Social media and consumer activism amplify the influence of consumer perception, compelling fast-food chains to become more environmentally responsible. Economic incentives and consumer education further drive the adoption of sustainable packaging options. In summary, consumer perception is reshaping the fast-food packaging industry, promoting eco-conscious choices and fostering positive change for both the environment and consumers. As consumers increasingly prioritize eco-conscious options, the industry is compelled to adapt, innovating toward more sustainable practices. This transformation underscores the interconnectedness of individual choices and their broader environmental consequences. The role of consumer awareness and preference is paramount in shaping the future of fast-food packaging, with the potential to drive positive change for both the environment and the evolving values of conscientious consumers. The visual appeal of product packaging is also a medium for marketing promotions (Silayoi & Speece, 2007). Some consumers are paying more attention to label information, as they become more concerned about health and nutrition (Coulson, 2000).

## 2. Research material and method

This study uses a quantitative research approach to investigate consumer perception and environmental impact of fast-food packaging. Primary data for this research was collected through a structured questionnaire and analysis was carried out using IBM SPSS software. The questionnaire was designed to include three main sections: demographic information, consumer perception and environmental impact of fast-food packaging, and quality aspect of food product packaging. The main data collection instrument for this study was a structured questionnaire. This questionnaire was carefully developed to ensure the capture of relevant information regarding consumer perceptions, awareness of environmental impact and quality aspects of fast-food packaging. The first part of the questionnaire collected demographic data to understand the profile of the respondents, including gender, age, education level, occupation, monthly income and region of residence. These details provide context and allow for demographic segmentation. The second part of the questionnaire delved into consumer perception of fast-food

packaging and its environmental impact. The questions in this section aimed to assess respondents' awareness of environmental issues related to packaging and their preferences for sustainable materials.

A random sampling technique was used to ensure that every potential respondent in some Kosovo regions within the target population had an equal chance of being included in the survey. This approach increases the representativeness of the sample. Target group of the study for the respondents were individuals aged 20 to 50 years. This age range was chosen to capture a diverse demographic that is likely to include a significant portion of fast-food consumers. Data analysis for this research was performed using IBM SPSS software. The quantitative data obtained from the structured questionnaire were entered into the software for statistical analysis.

In conclusion, this study adopted a quantitative research approach using a structured questionnaire to collect data regarding consumer perception and environmental impact of fast-food packaging. The research focused on a target age group of 20 to 50 years and included analysis of demographic information, environmental awareness and quality aspects of packaging. The IBM SPSS program was used for data analysis, facilitating a comprehensive examination of the information collected. The methodology used in this study provides a systematic and structured investigation into the aforementioned research area, providing valuable insights into consumer preferences and the environmental implications of fast-food packaging.

## 3. Results and discussions

Analysis of research results includes a comprehensive examination of demographic characteristics and consumer perceptions regarding fast food packaging. By dividing the data into two main sections – demographics and consumer perception a comprehensive understanding of the research findings emerges. In terms of demographics, the survey captured a diverse sample, including respondents in some Kosovo regions, from different age groups, genders, educational backgrounds, occupations and income levels. This diversity is essential as it reflects a broad spectrum of fast-food consumers and their potential influence on packaging preferences and environmental awareness.

Turning to consumer perception, the findings underscore the importance of environmental awareness. Respondents who exhibit a higher degree of environmental awareness are more likely to favor environmentally friendly packaging materials, such as biodegradable and recyclable ones. Additionally, the study examines how fast-food packaging can influence brand perception, shedding light on the value of consistency in maintaining a positive brand image.

Finally, the analysis delves into environmental pollution and recycling habits related to fast food packaging. These data not only highlight current recycling practices, but also highlight potential challenges within recycling systems, highlighting areas that require consumer education and infrastructure improvement as well as pollution reduction.

This integrated analysis serves as a critical basis for subsequent discussions and recommendations in the study. It provides actionable insights for fast food businesses, policy makers and stakeholders to develop sustainable packaging strategies, increase consumer engagement and align with evolving environmental expectations within the fast-food industry.

"The questionnaire aimed to understand people's preferences regarding fast food (Tab.1). 254 people were surveyed and each was asked to select the main factors they consider when making their choice when eating fast food. Options offered were Calories, Taste, Price, Customer Service and Location during the trip. The responses were analyzed and the results show that most respondents value the Calories and Taste factors the most, indicating a high interest in quality and nutritional content. On the other hand, Price is also an important factor, but seems to be given less attention compared to Calories and Taste. Customer service and location during the trip were determined to be the least important factors for this group of responses."

**Tab 1:** What main factors do you consider when choosing to eat fast food?

| What main factors do you consider when choosing to eat fast food? | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | Calories | 23 | 9.1 | 9.2 | 9.2 |
| | Taste | 169 | 66.5 | 67.9 | 77.1 |
| | The cost | 12 | 4.7 | 4.8 | 81.9 |
| | Consumer servis | 4 | 1.6 | 1.6 | 83.5 |
| | Location | 20 | 7.9 | 8.0 | 91.6 |
| | During the trip | 21 | 8.3 | 8.4 | 100.0 |
| | Total | 249 | 98.0 | 100.0 | |
| Missing | System | 5 | 2.0 | | |

| | | | | | |
|---|---|---|---|---|---|
| Total | | 254 | 100.0 | | |

"The question below was intended to assess the respondents' opinions regarding the impact of fast-food packaging on the environment (Tab.2). Out of 254 responses, the largest majority, i.e. 105 people, have expressed the belief that fast food packaging has a very large impact on the environment This expresses a strong concern for the environmental consequences of packaging, showing awareness about the impact of waste and materials used

**Tab 2:** Do you think fast food packing has a negative impact on environment? (Fill in one of the points1-5)

| Do you think fast food packing has a negative impact on environment? (Fill in one of the points 1-5) | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | Pak | 22 | 8.7 | 8.9 | 8.9 |
| | Rrallehere | 19 | 7.5 | 7.7 | 16.7 |
| | mesatarisht | 70 | 27.6 | 28.5 | 45.1 |
| | mbi mesataren | 30 | 11.8 | 12.2 | 57.3 |
| | Shume | 105 | 41.3 | 42.7 | 100.0 |
| | Total | 246 | 96.9 | 100.0 | |
| Missing | System | 8 | 3.1 | | |
| Total | | 254 | 100.0 | | |

"The majority of respondents, with a percentage of 55.1%, have expressed that they understand the meaning of the ecological signs placed on the packaging label (Tab. 3). This expresses a positive consensus among consumers regarding the meaning of such signs and an awareness about the importance of using packaging environmental. A small part of respondents, with a percentage of 5.1%, said that they do not understand the meaning of ecological signs. This small number can be explained by the lack of information or awareness enough about the signs used to identify environmental packaging.

Overall, the survey results show a growing awareness of environmental topics and a desire to understand and support products that have a positive impact on the environment."

**Tab 3**: Do you know to distinguish packaging that is less harmful to environment?

| Do you know to distinguish packaging that is less harmful to environment? | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | Yes | 140 | 55.1 | 56.9 | 56.9 |
| | No | 13 | 5.1 | 5.3 | 62.2 |
| | Some | 93 | 36.6 | 37.8 | 100.0 |
| | Total | 246 | 96.9 | 100.0 | |
| Missing | System | 8 | 3.1 | | |
| Total | | 254 | 100.0 | | |

The survey on willingness to pay more for food in biodegradable and bioplastic packaging gathered responses from 246 individuals (Tab. 4). The results show a spectrum of attitudes:

Not Ready: 29 respondents (11.4%) are not willing to pay extra, possibly prioritizing other factors.

Ready to Some Extent: 26 respondents (10.2%) are open to the idea but with reservations on the additional cost.

Average Ready: 77 respondents (30.3%) are moderately committed to paying more for environmentally friendly packaging.

Ready: 43 respondents (16.9%) express clear readiness to pay more, showing a higher value on sustainability.

Very Ready: The largest group, 71 respondents (28.0%), are highly committed to paying extra for eco-friendly

packaging, indicating a strong alignment with environmental sustainability.

In summary, the survey suggests that around 60.64% of respondents have some level of willingness to pay extra for environmentally friendly packaging, with a significant portion (28.0%) expressing a high level of commitment to supporting sustainable practices.

**Tab 4:** How much more are you willing to pay food in biodegradable and packing to protect the environment? (Fill in of the points 1-5)

| How much more are you willing to pay food in biodegradable and packing to protect the environment? (Fill in of the points 1-5) | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Not ready | 29 | 11.4 | 11.8 | 11.8 |
| | Ready to some extend | 26 | 10.2 | 10.6 | 22.4 |
| | Average ready | 77 | 30.3 | 31.3 | 53.7 |
| | Ready | 43 | 16.9 | 17.5 | 71.1 |
| | Very ready | 71 | 28.0 | 28.9 | 100.0 |
| | Total | 246 | 96.9 | 100.0 | |
| Missing | System | 8 | 3.1 | | |
| Total | | 254 | 100.0 | | |

The survey respondents overwhelmingly identified plastic as the most harmful type of fast-food packaging to the environment, with 211 individuals (83.1%) expressing this concern (Tab.5). This widespread perception aligns with the well-documented environmental impact of plastic waste. While there were minimal concerns raised about metal, glass, paper/cardboard, and tetra pack materials, the dominance of plastic in respondents' views underscores the urgent need for sustainable alternatives and heightened awareness campaigns to address the environmental challenges associated with plastic packaging in the fast-food industry. This consensus offers valuable insights for businesses and policymakers aiming to prioritize eco-friendly practices and reduce the environmental footprint of the packaging used in the fast-food sector.

**Tab 5:** Which types of fast-food packaging do you think are the most harmful to the environment?

The question was intended to assess the respondents' opinions regarding the best way to educate more people about reducing food waste and environmentally friendly packaging (Diagram 1.).

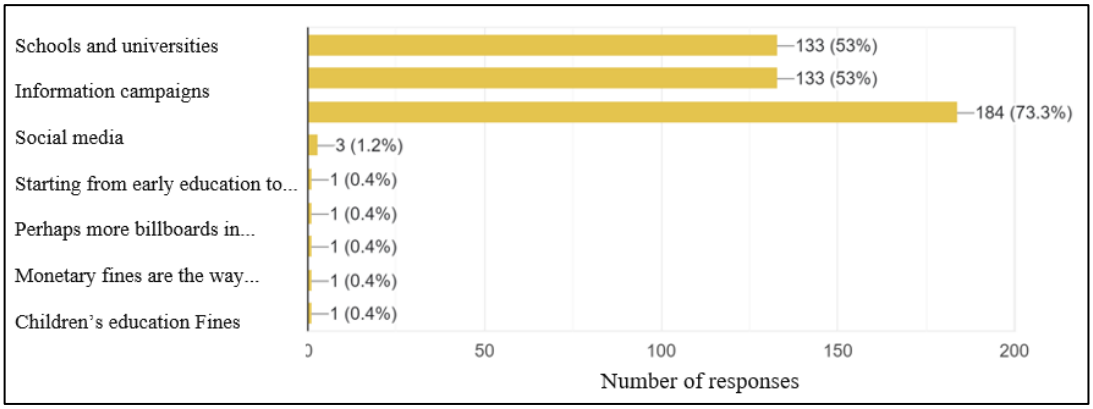


**Diagram 1:** Which types of fast-food packaging do you think are the most harmful to the environment?

"The question was intended to assess the respondents' opinions regarding the best way to educate more people about reducing food waste and environmentally friendly packaging (Diagram 1.). The survey indicated that schools and universities, as well as information campaigns, are considered equally effective in educating the public about reducing food waste and using environmentally friendly packaging, each receiving 53% (133 responses) of participant support. Social media stands out as the primary educational tool with a notable 73.3% (184 responses), highlighting its significant reach and influence in raising environmental awareness. While the majority of participants show a clear understanding and endorsement of educational methods that promote environmental consciousness, a minuscule segment appears to be less informed, possibly due to a deficiency in accessible

information or general awareness about environmental packaging signs. In summary, the findings reflect a general trend of increased environmental awareness and a proactive stance among consumers to engage with and support environmentally responsible practices."

## 4. Conclusions and recommendations

According to the findings from this research we can conclude that Environmental awareness is growing: Research reveals a growing environmental consciousness among fast food consumers. A significant proportion of respondents expressed awareness of the environmental impact of packaging, emphasizing the need for businesses to prioritize sustainability. Preference for sustainable materials: Consumers increasingly prefer fast food packaging made from environmentally friendly materials such as biodegradable and recyclable. Brands that adopt these materials are likely to do well with environmentally conscious consumers.

As recommendations are to adopt sustainable packaging practices: Fast food businesses should switch to sustainable packaging materials, such as biodegradable and recyclable ones. This move aligns with consumer preferences and reduces environmental impact. Companies must share transparent information with ecological signs and sustainable packaging for consumers regarding packaging materials. Companies should encourage the use of biodegradable packaging materials, such as compostable plastics or plant-based materials, to reduce environmental impact and promote decomposition. Companies should introduce take-back programs where customers can return used packaging to designated collection points for proper disposal or recycling.

By implementing these recommendations, fast food businesses can not only meet the growing demand for sustainable packaging, but also contribute to reducing the environmental impact of their operations. This approach aligns with consumer expectations and positions brands as responsible stewards of the environment, driving customer loyalty and long-term success in an increasingly environmentally conscious marketplace.

Since there is still no in-depth study in the field of waste generation from fast-food packaging in Kosovo, I hope that this study will serve as an Incentive for further research.

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