

## THE STUDY OF THE INFLUENCE OF THE CARDBOARD PACKAGE ON THE QUALITY OF THE FOOD PRODUCT. CASE STUDY – PIZZA PACKED IN CARDBOARD BOX

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### Abstract:

*Food packaging is not considered any more just a necessary accessory to protect and transport the goods, it currently plays a complex role – technological, for protection, and for marketing. Because the packaging comes into direct contact with the product, it requires a number of restrictions and safeguards on the material used to make packaging, in order not affect the quality and safety of packaged food. However, migration of packaging constituents into food could not be stopped entirely. Developments in food packaging materials have significantly improved their stability, but nevertheless, we can affirm that it doesn't exist an ideal material for packaging, which shows only benefits.*

*In this paper we studied the influence of the cardboard box on a very popular product - pizza which is very often delivered in this type of packaging. The results show that there is the phenomenon of migration from the cardboard to the product and package significantly affect the quality characteristics of the food. One can say that there is an interaction between packaging and product, which results in lower quality and the emergence of risks associated with consumption of pizzas packed in cardboard boxes. Analyses were performed on unpackaged items at a time of packing and two hours after package. We noted that the properties of the product which is longer in contact with the cardboard are not the same as when placing into the package.*

*All food properties change due to inward migration of components to product packaging material.*

**Key words:** food quality, food safety, cardboard package, migration process

**JEL classification:** D18

## INTRODUCTION

Food is a universal human need and people hope and expect from their foods not to hurt them. The problem of food safety and food security is becoming an international concerning. More and more firms involved in food processing and distribution are trying to find the appropriate methods to limit the degradation of the products and to assure the food safety and security.

Food safety is describing the handling, preparation, and storage of food in ways that prevent food-borne illness. This includes a number of routines that should be followed to avoid potentially severe health hazards.

One of the most important methods used for assuring the food safety is packaging. The package is a very important accessory for the food product because it has to fulfil the following requirements:

- to assure an appropriate protection for the food product against the environmental factors;
- not to interact with the food in order not to change the product's properties;
- to create an inner environment favourable for the food, which do not allowed the development of micro organisms;
- to contribute to the promotion and marketing of the food product;
- to represent a mean of information for the consumers.

Food packaging can retard product deterioration, retain the beneficial effects of processing, extend shelf-life, and maintain or increase the quality and safety of food

Because the packaging comes into direct contact with the product, it requires a number of restrictions and safeguards on the material used to make packaging, in order not affect the quality and safety of packaged food.

In our paper we studied the influence of the cardboard package on the quality of pizza through the sensorial, physical and chemical properties of the product and we tried to assess the migration process.

## 1. LITERATURE REVIEW

The safety of feed and food at any point in the chain from producer to consumer is of worldwide concern. Food safety hazards may be introduced at any stage, therefore adequate control throughout the production chain is essential. A report of the ISO published at the end of 2008 ([www.iso.org/isofocus](http://www.iso.org/isofocus)) underlined that unsafe food is a risk for all – consumers can become seriously ill, and the industry can face costly corrective actions. Communication and raising awareness of potential hazards throughout the entire food chain – and therefore not restricted to one's company or department – is crucial. Food safety is a joint responsibility for all of the participating parties.

The European Union has a comprehensive food safety strategy. This covers not just safe food, but also animal health and animal welfare, and plant health. The strategy ensures that food is traceable as it moves from the farm through to table, even if this means crossing internal EU borders, so that trade is not held up and we have choice and variety in our food. The high standards are applied to food produced inside the EU and to food imports. ([http://europa.eu/pol/food/index\\_en.htm](http://europa.eu/pol/food/index_en.htm)).

Because peoples are getting more meals away from their homes, they need to be sure that food is safety and gets no risks for the consumers. Restaurants and other food services businesses are concerning to adopt the appropriate management methods to improve their activities and to avoid any kind of problem regarding the food safety (Redman, 2007).

The scientific literature is very abundant in works regarding the specific risks associated with processing, packaging, delivering and preserving the food. Hemminger (2000) makes a detailed description of the food hazards which can cause food safety problems and discuss about the facilities and the equipments used for controlling and monitoring the food preparation and other food services. The role of the package is outlined in the context in which more and more foods are delivered and consumed in a different location compared to the place of production.

The modern management of the restaurants is based on HACCP method and implementation of the ISO 22000 standard. In its book, Stavrositu (2008) pays a special attention to the management of the restaurants with all its aspects: organization, supply, food preparation and preservation, sanitation rules, service delivering and food safety. We can find here an interesting guide to implement the HACCP method in a restaurant which assures simultaneously the safety and the quality of the products. The time between cooking and serving the product is an important parameter in the assessment of its quality. Also, the specific food hazards for a restaurant are enumerated and described.

About the role of the package and the materials used for packaging, Marsh and Bugusu (2007) described the main roles as: protection/preservation of food products from outside influences and damage, containment and food waste reduction, marketing and information, traceability, convenience, and tamper indication. It is obvious that no packaging material can fulfil all these roles alone, because any of them is characterized by advantages and disadvantages. The trend is to combine different packaging materials with the aim of eliminate the disadvantages and use the advantages (Albu, 2006).

The direct contact between food product and its package lead to the phenomenon of migration – the mass transfer through the two parts in both directions. For the food safety it's important the migration from the package to the product which brings in the food contaminant substances. The migration is a slow process, so the contact time between package and product has a major importance (van Willige, 2002).

The migration process has two main impacts on the package food:

- the first impact is on the food safety – some compounds from package can be very dangerous if it will arrive in the food in sufficient quantity;
- the second impact is on the food quality – the substances which have migrated can affect the sensorial and chemical properties of the food (van Willige, 2002).

The requirements for the cardboard used for food package are specified in the EU legislation, making the difference between new cardboard and cardboard obtained from recycled materials. It is specified very clearly that the migration process from cardboard boxes and food products doesn't have to allow the transfer of dangerous products which can affect the health of the consumers. Also, there are very strict limits for the heavy metals compounds, chlorine and other organic compounds (Barnes and others, 2007).

For the specific food product we have studied – pizza – there is information about the requirements for the cardboard box: to protect the product against the light, to limit the transfer of the oxygen, water vapours and carbon dioxide from the atmosphere, to maintain the temperature and the humidity inside the box (Ahvenainen, 2000). The cardboard for pizza represent a real risk if they are produced from recycled paper; the traces of inks, glues, paints and other chemicals were found in the pizza by the Italian researchers from Milan University (2008). The main explanation of the migration phenomenon is the high temperature inside the box, (aprox. 65°C), which enhances the mass transfer. All the studies affirm the existence of the migration process, but can not assess precisely the quantity of the compounds transferred to the food product.

## **2. MATERIALS AND METHOD**

In our research we studied the both parts involved in the migration process – the package and the food product.

### **2.1. THE CARDBOARD PACKAGE BOX**

Package design and construction play a significant role in determining the shelf life of a food product. The right selection of packaging materials and technologies maintains product quality and freshness during distribution and storage.

The use of paper and paperboards (as cardboard) for food packaging dates back to the 17th century with accelerated usage in the later part of the 19th century (Coles, 2003).

Cardboard is thicker than paper with a higher weight per unit area and often made in multiple layers. These features lead to better barrier properties than paper. It is commonly used to make containers for shipping – such as boxes, cartons, and trays, and seldom used for direct food contact. Pizza delivered in cardboard boxes represents an exception from these usual types of paperboard package. There are 4 main types of cardboards used for packaging the food: white board, solid board, chipboard and fibreboard.

Brown board – is made from several thin layers of not bleached chemical pulp, is typically used as the inner layer of a carton; it is the only form of cardboard recommended for direct food contact.

Solid board – has multiple layers of bleached sulphate board which give strength and durability. When laminated with polyethylene, it is used to create package for liquids (milk, fruit juices, soft drinks).

Chipboard – is made from recycled paper and often contains blemishes and impurities from the original paper, which makes it unsuitable for direct contact with food. The least expensive form of paperboard, chipboard is used to make outer packaging.

Fibreboard – can be solid or corrugated; the solid type has an inner white board layer and outer Kraft layer and provides good protection against impact and compression. The corrugated type, also known as corrugated board, is made with 2 layers of Kraft paper with a central corrugating (or fluting) material. Fibreboard's resistance to impact abrasion and crushing damage makes it widely used for shipping bulk food and case packing of retail food products, but not appropriate to direct contact with food.

The cardboard package which enter in direct or not direct contact with the food don't has to allow the migration process of its own compounds to the food product. Because this is not possible (it doesn't exist an ideal cardboard), the substances from the package which are migrating to the food must not overcome the safety limits.

In the particular case we studied, the cardboard box for pizza was made from brown paperboard. The main analysis we made for package box were the measuring of its mass at various moments of time and the describing of its aspect. For the assessment of the mass variation we weight the cardboard box at 3 different moments: before entering the pizza inside the package, after 1 hour and after 2 hours from the moment of packaging.

At these 3 moments taken into consideration we also have analyzed the aspect of the box.

## 2.2. THE FOOD PRODUCT – PIZZA

Pizza is a traditional Italian food consisting in a thin piece of bread with circle form, covered by tomatoes juice and cheese, with different toppings, backed in oven. The name of this very delicious food came from Latin word *pissa*, which means "plane bread". The first pizzeria was opened in Naples in 1830 and it is still working now days. Till the Second World War pizza was known in France, England or Spain, but the foreign soldiers tasted this plate and spread it all over the world.

At the beginning, the dough was made only from wheat flour, salt, yeast and water, but during the time was added more ingredients like olive oil, sugar, milk or eggs. The mozzarella cheese and tomatoes juice are mandatory ingredients, besides them can be added vegetables, salami, sausages, meat, fish, even fruits. There are hundreds of recipes for pizza which satisfied all consumers' tastes.

For the study we choose the classical pizza made with bacon, mozzarella, mushrooms, onion, olives, tomatoes sauce.

Our study had the purpose to determine the influence of the cardboard package on the quality of the pizza. For this, we used several lab analyses for the assessment of the product quality:

- sensorial evaluation,
- physical and chemical determinations
- microbiological analysis.

From the first group, we evaluate the overall aspect of the product, including the dough and the ingredients aspect and the aspect in the section, the smell, the taste and the consistency. As work method, we used the Score method with the scale from 0 to 20 points.

The other group of methods consisted of the analysis of: water, fats, salt and other minerals content and acidity value (pH).

The microbiological analysis determined the number of micro organisms colonies.

All the analyses were performed at three moments of time, the same moments took into account for the package box assessment, e.g. after cooking the pizza (before entering the cardboard box), after 1 hour and after 2 hours from the moment of packaging.

The values of the lab determinations and the sensorial observations were used for the assessment of the influence of the paperboard package on the quality of the pizza and were compared with the values recommended from the standard of the product. The process was repeated for every moments of time took into consideration.

## 3. RESULTS AND DISCUSSION

After making the determinations listed above, we obtained the following results:

### 3.1. THE CARDBOARD PACKAGING BOX

The properties at the 3 times mentioned are presented below:

*At the first stage* – before entering the pizza into the package:

- we used a paperboard box with lid;

- the weight of the cardboard box – 140 g;
  - the dimensions were 30 x 30 x 6 cm;
  - the box was clean, without spots and unpleasant smells.
- At the second stage* – after 1 hour from the moment of packaging:

- the dimensions remained the same;
- the weight of the box – 162 g;
- we noticed some spots on the lid in the places where the pizza touched the box.

We considered that the increasing of the mass is due to two factors: first, the water vapours condensation from the inner atmosphere into the box, and second, due to the migration process, some fats from the ingredients passed to the cardboard box.

*At the third stage* – after 2 hours from the moment of packaging the pizza: all the process noticed at the previous stage continued, the mass was 175 g, the surface of the spots covered more than a third of the surface of the lid and there were spots on the bottom of the box, too.

### 3.2. RESULTS OF THE SENSORIAL ASSESSMENT OF THE PIZZA

The sensorial evaluation of the pizza used the following table with the scores for different sensorial properties:

**Table no. 1. The scores for the sensorial assessment**

| Sensorial properties  | Scores                   |
|-----------------------|--------------------------|
| External aspect       | 3 points maximum         |
| Aspect in the section | 5 points maximum         |
| Consistency           | 3 points maximum         |
| Taste                 | 5 points maximum         |
| Smell                 | 4 points maximum         |
| <b>TOTAL</b>          | <b>20 points maximum</b> |

Using this score method, we can have 5 quality classes:

**Table no. 2. The quality classes for the sensorial evaluation of the pizza**

| Score [points] | Quality group    |
|----------------|------------------|
| 19,5 – 20      | Excellent        |
| 18 – 19,4      | Very good        |
| 16 – 17,9      | Good             |
| 13 – 15,9      | Satisfactory     |
| under 13       | Not satisfactory |

After the assessment of our product at the three stages mentioned above, we obtained the following results:

**Table no. 3 Sensorial analysis of the pizza**

| Sensorial properties  | Score after the first stage | Score after the second stage (1 hour) | Score after the third stage (2 hours) |
|-----------------------|-----------------------------|---------------------------------------|---------------------------------------|
| External aspect       | 3                           | 2,5                                   | 2                                     |
| Aspect in the section | 5                           | 4,5                                   | 4,5                                   |
| Consistency           | 3                           | 3                                     | 2,5                                   |
| Taste                 | 5                           | 5                                     | 4,5                                   |
| Smell                 | 4                           | 3,5                                   | 3,5                                   |
| <b>TOTAL</b>          | <b>20</b>                   | <b>18,5</b>                           | <b>17</b>                             |

The total score obtained by the pizza led us to the conclusion that the quality is going down during the time of packaging in the paperboard box. At the first stage, before packaging the food product, the score for all the properties were maximum, so we graded the product in the "Excellent" class of quality; after 1 hour, the score was 18,5 points, the properties which had a decreasing score were external aspect, the aspect in section and the smell. The pizza was graded in the second quality class – "Very good".

In the third stage, after 2 hours of packaging, all the properties were decreased, so we score the product with 17 points, which means the "Good" class of quality.

As a partial conclusion, the sensorial properties are influenced by the time of staying in the package box, as time is longer, the properties are decreasing.

### 3.3 RESULTS OF THE PHYSICAL AND CHEMICAL DETERMINATIONS

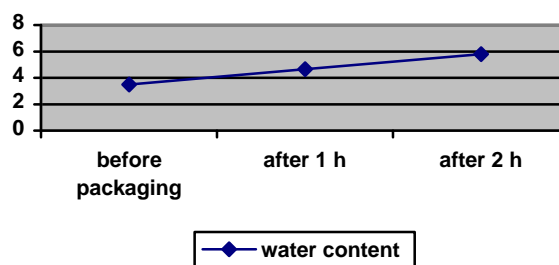
The main analyses performed were: determination of water, fats and salt content and pH value, repeated at every of those three stages of analysis.

Water has an important influence on the consistency and viscosity of the food products. It represents the dissolution medium for a lot of compounds and favours the development of the micro organisms. A value of the water content more than 16% favours the development of the moulds and at values bigger than 20 – 30% are developing the bacteria and yeasts. In our research we used the indirect method for the determination of the water content – determination of the dry substance. The values corresponding at the three stages of analysis are shown in the following table and graph:

**Table no. 4. Variation of water content**

| Before packaging | After 1 hour | After 2 hours |
|------------------|--------------|---------------|
| 3,48 %           | 4,65 %       | 5,8 %         |

For pizza product, the maximum value accepted for the water content is 10%.



The cause of the rising of the water content is the condensation of the water vapour from the atmosphere. The packaging box has a porous structure which allows the movement of the vapour into the box. Even the water content is rising, the values still remain under the upper limit of 10%, but more water in the product is the main cause of the decreasing the quality.

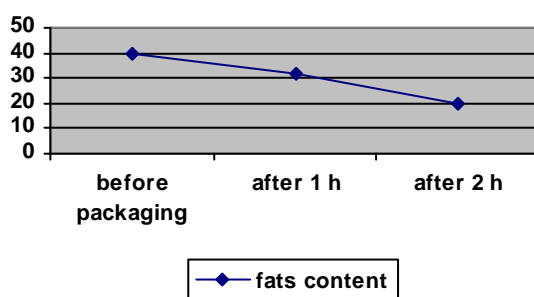
The fats are important ingredients in a food recipe; they improve the taste and led to the fullness feeling.

For determining the fats content we used a very popular and known method – Soxhlet method, and we obtained the following results:

**Table no. 5. Fats content in the pizza**

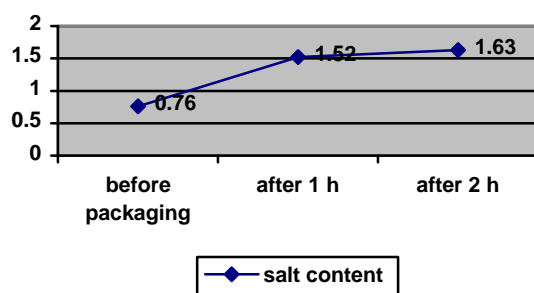
| Before packaging | After 1 hour | After 2 hours |
|------------------|--------------|---------------|
| 40 %             | 32 %         | 20 %          |

The fats content is decreasing during the package period and we assumed that the reason is the migration process from the pizza to the cardboard box. The spots on the packaging box are come especially from the fats of the product; those are in the liquid form due to the high temperature of the pizza after cooking.



The values are not exceeding the maximum limit claimed in the pizza standard – 40 %, which is attained only at the first stage, before packaging.

The salt from the pizza come from some ingredients (bacon, olives) and also was added according to the recipe. The maximum value of the salt content can be 3%, as the value is higher, as the quality of the product is lower. Due to the migration process, the salt content is rising during the staying in the cardboard box, as we can see from the graph below:



During the first hour of packaging the increasing of salt content is grater, the value after 1 hour is more than double regarding the initial one. All the values are under 3%, so we can consider that the pizza can be consumed, even if the quality is getting worse.

The content of the other minerals from the pizza was determined from the dust remained from the calcinations of the product, using the X-ray spectroscopie EDX connected at computer. In the table no. 6 is the variation of the mineral content during the two hours period.

**Table no. 6 Minerals content in pizza**

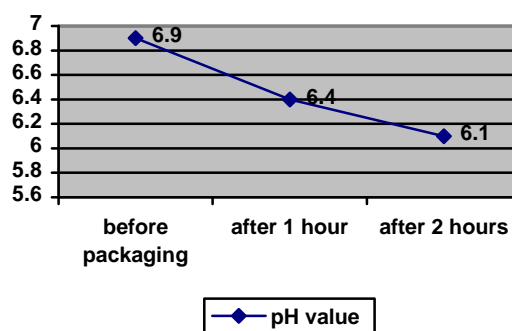
| Mineral substance | Before packaging | After 1 hour | After 2 hours |
|-------------------|------------------|--------------|---------------|
| Chlorine          | 58,148%          | 20,304%      | 9,358%        |
| Calcium           | 18,118%          | 10,234%      | 5,346%        |

|           |               |               |               |
|-----------|---------------|---------------|---------------|
| Potassium | 13,182%       | 10,235%       | 9,876%        |
| Phosphor  | 8,869%        | 8,476%        | 8,123%        |
| Sulfur    | 1,269%        | 1,108%        | 0,986%        |
| Iron      | 0,128%        | 0,034%        | 0,001%        |
| Zinc      | <b>0,127%</b> | <b>0,683%</b> | <b>1,25%</b>  |
| Cooper    | <b>0,047%</b> | <b>1,396%</b> | <b>1,987%</b> |
| Bromine   | 0,029%        | 0,023%        | 0,013%        |
| Chromium  | <b>0,024%</b> | <b>0,149%</b> | <b>0,954%</b> |

As we can notice, the content of the minerals is decreasing at the major part of them, except zinc, cooper and chromium which record an increasing percentage; this fact can be dangerous for the consumer because these three minerals are included in the group of heavy metals – metals with high toxic potential. Comparing with the maximum values stipulated in the Government Decision no. 1197/2002, we found that they are grater than upper limit, which is a negative aspect.

We consider the migration process the cause of these results, the mineral from the paperboard are passing in the pizza during the staying in the packaging box.

The last analysis from this group was the acidity determination (pH value). The acidity of a food product is a very important indicator which gives information about the freshness status. As the food is loosing the freshness, as it becomes more acid. The limit value for the acidity is 6, superior values (which means pH less than 6) indicates a low quality for the product. With all the ingredients used for making the pizza, it has neutral to weak acid character. For the measurement of the pH values we used the digital pH-meter; the results are shown in the graph below:



The acidity of pizza is growing without overcoming the limit value, but we can affirm that after 2 hours of staying in the paperboard box, the pizza has poor properties, at the limit of acceptance.

### 3.4. THE RESULTS OF THE MICROBIOLOGICAL ANALYSIS

All the foods are very good media for the development of the micro organisms due to the nutrients from the composition of these products. The presence of water and the high temperatures favours, also the multiplication of the bacteria. For pizza, the maximum number of the micro organisms' colonies is 10000 at 30 °C. For our product, the results of the microbiological analysis are:

**Table no. 7. Number of micro organisms colonies**

| Time [min] | Number of micro organisms colonies |
|------------|------------------------------------|
| 0          | 8000                               |
| 60         | 9000                               |
| 120        | 10000                              |



This analysis shows, too, that the quality of the pizza falls during the package in the box, the characteristics after 2 hours are on the lower limit of acceptance.

#### 4. CONCLUSIONS

This paper deals with the influence of the package on the quality of the food product, studied through the sensorial, physic, chemical and microbiological properties. The study focused on a very popular product – pizza – which very often arrives at the consumer in a cardboard box. Because the traffic becomes more and more heavy, pizza arrives at the destination after a longer time. This fact influences the characteristics of the product, whose quality is getting worse. The cardboard box creates a micro-environment into the package which favours the migration process in both senses which affect the quality of pizza. After 2 hours of staying in the package the product reaches the lower limit of its properties and it is not recommended to be consumed.

After this study, our opinion is that pizza has to be consumed immediately after the cooking and if it has to be deliver at a different place from the one where was made, the time must not overcome 1 hour.

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