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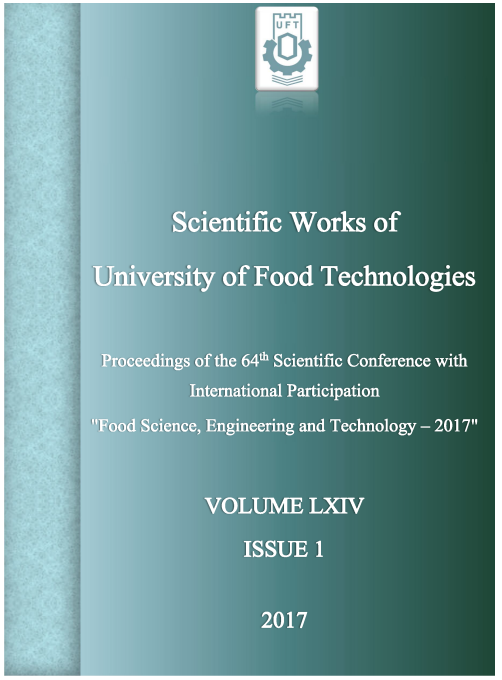

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# Changes of Fatty Acids Composition in Yogurt Packed in Different Packaging Materials

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**Abstract**
Food quality and safety depend to a great extent on packaging materials used. Adequate and functional packing materials have to be chosen in order to keep nutritive values and quality properties of food as long as possible. The main objective of this work was to analyze the changes of fatty acids composition of yogurt packed in different packaging material. The yogurt samples were grouped into two groups according to the type of packaging materials (carton and plastic) and were stored at +4°C. Samples for analysis were taken on each 7th day during the period of 28 days. The following parameters were examined: fat content, dry matter content and acidity. Changes of fatty acids composition during the examined period in both groups of samples were analyzed by gas chromatography. Also microbiological analysis of yogurt samples was done. The obtained results did not show significant differences ($p<0.05$) in the fatty acids compositions between yogurt samples packed in carton and plastic materials.

**Practical applications**
In general, the interests and objectives of the food industry are aimed to obtain a quality and safe product. Packaging as the final stage of the production process and the appropriate storage conditions of the food product enable maintenance of its quality and safety up to use. The properties of the packaging material plays a major role in the preventing of external factors and therefore the delay in the processes that lead to spoilage of the product. Yogurt is fermented dairy product with complex composition. Milk fat plays an important role in the formation of the viscosity, texture, taste and color of yogurt. The main objective of this work was to analyze the changes of fatty acids composition of yogurt packed in different packaging material. The obtained results in this study underline the importance of the packaging material and the appropriateness of the storage conditions for the maintenance of the quality and safety of food products up to their use.

**Key words:** fatty acids composition; packaging material; yogurt; gas chromatography; food quality

## Introduction

Yogurt is a fermented dairy product with ancient origin. It is assumed that it originated perhaps 10,000–15,000 years ago, from adventitious contamination by lactic acid bacteria of milk in traditional containers such as earthenware pots or containers made from animal skins. Over time, the preservation of milk by making fermented milk products spread around the world, wherever milking animals were domesticated, and numerous types of traditional fermented milk products emerged, depending on the source of milk and the microbial cultures and manufacturing methods used. Ilya Ilyich Metchnikov had scientifically confirmed yogurt`s beneficial properties. He considered that the longevity of the Caucasian population was a result of the frequent use of fermented dairy products (Chandan, 2010; Roger & MacBean, 2010).

Nowadays definition for the yoghurt is that it is "a fermented milk product obtained with use of symbiotic starter containing *Lactobacillus bulgaricus* and *Streptococcus thermophilus".*

Yogurt is well recognized as a healthy product. The investigations showed that the yoghurt consumption has positive effect on the healthy balance of microbes' population in human digestive tract. Rich of calcium, easy to assimilate, the yoghurt is an important source of this element (Rogelj, 2000).

The composition of yogurt products varies according to the tastes of the market and the specific segment in the market. The milk fat content may vary from virtually zero for skim milk yogurt products to more than 4% for "indulgence" products and even up to 8% or 9% for Greek-style products. Protein levels may be the same as those of the milk from which the yogurt is made (between 3% and 3.5%) or significantly greater in order to increase the firmness of the coagulum. Yogurt contains the nutrients of the milk fat, milk protein, lactose, and the minerals and vitamins of its milk components, as well as other nutrients, such as those from added fruit preparations, and is widely recognized as a nutritious product (Tratnik, 1998). From a product that in ancient times allowed milk to be preserved for a few days, today yogurt is a product which contain live starter and probiotic cultures that have refrigerated shelf lives of several weeks (Roger & MacBean, 2010; Chandan, 2010).

The preservation of yogurt's nutritional, physico-chemical, texture and sensory properties during storage is of great importance. It is well known that during the storage time changes in pH and titrable acidity values occur. These changes are closely connected to changes in the sensory properties and the flow behavior of the fermented milk products (Hrushcak, 2005; Karsheva et al., 2013).

Due to the specific chemical composition and susceptibility to microbial contamination, yogurt belongs to a group of easily perishable food products (Germani et al., 2014).

A wide range of packaging materials is used for packing of yogurt products.

As with virtually all packaged food products, the package in which a yogurt product is provided to the consumer is of major importance. It must provide a safe, convenient, attractive, functional, and cost effective means for protecting the product throughout distribution and merchandising, for presenting it to the consumer, and for enabling easy consumption. Factors affecting the environmental impact of packaging must also be taken into consideration, and these are likely to become even more important in the future. Thus, selection of the packaging materials and of the package design must take into consideration: physical product protection, protection of sensory properties, food safety, and aesthetic, functional, environmental, and cost issues (Roger & MacBean, 2010).

Yogurt is fermented dairy product with complex composition. Milk fat plays an important role in the formation of the viscosity, texture, taste and color of yogurt. The main objective of this work was to analyze the changes of fatty acids composition of yogurt packed in different packaging material.

## Materials and Methods

For the purpose of this study were used yogurt samples (n=40) produced during the same technological process, but packaged in different packaging material (plastic and carton). The yogurt samples were grouped into two groups according to the type of packaging materials (carton and plastic) and were stored at 4°C. Samples for analysis were taken on each 7th day during the period of 28 days (0; 7; 14; 21 and 28 d). For the analysis of chemical composition of yogurt, the following parameters were examined: fat content, dry matter content and acidity.

*Chemical analysis of yogurt samples*

The fat content was analysed by Gerber method. The content of total solids was determined by the drying method. Yogurt acidity was analysed by Soxhlet-Henkel method.

*Microbiological analysis of yogurt samples*

The microbiological analysis of the samples of yogurt was determined by performing analysis of the possible presence of *Enterobacteriaceae* (ISO 21528-2).

*Fatty acids composition*

Extraction of fat was performed using 25% ammonia, 95% ethyl alcohol and hexane (Rose-Gottlieb, AOAC, 1990, modified according Secchiari et al. (2003). To minimize oxidative degradation of fatty acids the butylated hydroxytoluene was added as a preservative. Fatty acids were than trans-esterified with $BF_3$/Methanol into fatty acid methyl esters (FAMES). Fatty acids methyl esters (FAMEs) were prepared according to AOAC Official Method 996.06 Analyses of the FAMEs were carried out on a GC-FID, (GC Agilent Technologies 7890 GC System, CN 11251075, USA). Column HP88 (J&W 112 -8867; 250°C; 60m x 250mm x 0.2 mm, Agilent, USA) was used for FAMEs analysis. The reliability and accuracy of the analytical method for the detection of fatty acids were ensured by use of the certified reference matrix that consisted a mixture of 37 FAME standards (Supelco 37 Component FAME mix, Sigma-Aldrich). The content of the particular component is expressed as percentage from the sum of all analyzed fatty acids.

*Statistical analysis*

The analysis of variance (ANOVA) tests were carried out by using the general linear model procedure of the SPSS. The means were separated by Tukey HSD. Significant differences were determined at p-value $p<0.05$.

## Results

*Changes in chemical composition of yogurt*

The changes in the chemical composition of the yogurt samples were followed in a period of 28d. Samples were taken on 0, 7, 14, 21 and 28d. The results of the analysis of fat content, total solids and acidity are preseted in the Table 1. Obtanied results have shown changes in the value of the acidic degree, which in the group of samples packed in plastic packaging ranges from 32.8°SH to 41.2°SH, while in the group of samples packed in a carton ranges from 34.0 to 41.2°SH. For both groups of samples, the highest acid value is set at 14 days. According to the obtained results, the yogurt packaged in a carton pack (tetrapack) and stored at 4°C in relation to the one packaged in a plastic cup and stored at 4 °C, during the analyzed period (except for 28 days) shown a constantly higher percentage of nonfat solids, and lower fat content. Statistical analysis of the obtanied results has shown that the diffreneces between analysed parameters is not statistically significant ($p<0.05$).

In this study, through the analysis of the fatty acid composition of yogurt samples, the efficiency of the plastic and carton-tetrapack in the maintenance of the product quality was examined (Fig. 1 and Fig. 2).

Based on the statistical processing of the obtanied results, the diffreneces between the two groups of samples are not statistically significant ($p<0.05$), which indicates that both types of packaging material enable uniform maintenance of the product quality.

According obtanied results of analysis of fatty acids profiles of yogurt samples in highest content was present palmitic acid (C16:0), than follow stearic (C18:0) and miristic acid (C14:0) from saturated fatty acids. The oleic acid (C18:1n9c). is most abundat unsturated acid.

Results from the micobiological analysis of the quality and safety of yogurt samples packed in different packaging material during analysed period have shown that analized types of packing materialas are equaly effective regarding in prevention of the microbial contamination of the product, and that the yogurt samples comply with the Rulebook on specific requirements concerning microbiological criteria for foods Official Gazette of R. Macedonia No. 100/2013.

## Discussion

The quality and safety of food products from their production until their use depends to a large extent on the conditions of storage and the type of packaging material used for their packaging. During the storage period of yogurt, microbiological, enzymatic and chemical changes are taking place that can negatively affect the overall quality of the product and its durability. Considering the fact that from a microbiological and biochemical point of view the primary purpose of the packaging of food products is avoiding microbial contamination, its slowing down or prevention of degradation processes, continuing usability of the product, this study was toworded to the analysis of the effectiveness of protective role of packing material during above mentioned processes (Floros et al., 1997). Subject of the analysis were two types of packaging material (carton and plastic packaging), which are most commonly used for packaging of yogurt.

Yoghurt belongs to the group of easily perishable products. Many factors (external and internal) contribute to its spoiling. From the external factor specifically highlights the impact of light, temperature and oxygen (Dave et al., 2002; Linssen et al., 1991).

In this study a comparative analysis of the efficiency of two types of packaging material (plastic and carton) was carried out regarding the maintenance of the quality and safety of the yogurt. Because one of the changes that may occur as a result of an inappropriate way of yogurt storing is lipolysis, in this study,

through the analysis of the fatty acids composition of yogurt samples, the efficiency of the carton and plastic packaging in maintaining the quality of the product was analysed.

Similar study have been performed by Ilic et al., 2003. They have dectrese of lactose content in all samples decreased during storage, with different dynamics depending on the type of used inoculum. The greatest differences in lactose concentration are on ten day storage.

Microbiological spoilage of dairy foods is characterized by gustative and odor changes such as sour, putrid, bitter, malty, fruity, rancid etc... This type of spoilage may also lead to undesirable changes in body, texture and consistency. Physical and chemical factors like oxidation, irradiation, lipolysis, heat, light, metal ions or temperature increase during processing and storage may also be responsible for taste deterioration. In addition chemical processes also may bring about changes in physical properties like viscosity and separation (sedimentation). The microbial and physical quality of the raw material often determines the shelf life of a food. Processing parameters e.g. type and extent of heating and cooling, degree to which the food is concentrated, fermentation, incorporation and distribution of ingredients such as salt, sanitation of equipment and environment, packaging, storage temperature, humidity and exposure to odors can also influence the product shelf life (Mestadg et al., 2005; Robertson, 2006; Ilic et al., 2012).

## Conclusions

The results of the current study showed that analyzed chemical and microbiological parameters yogurt samples are within acceptable national and standards Based on the obtained results, both type of packing material have shown similar effectivness in the protection of the product.

The results obtained underline the importance of the packaging and the appropriateness of the storage conditions for the maintenance of the quality and safety of food products up to their use.

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**Table 1.** Chemical composition of yogurt packed in difffrent packing material and stored at 4°C

| | Packing material | Days | | | | |
|---|---|---|---|---|---|---|
| | | 0 | 7 | 14 | 21 | 28 |
| **Fat (%)** | plastic cup | 2.8 | 2.8 | 2.8 | 2.7 | 2.7 |
| | carton tetrapack | 2.7 | 2.8 | 2.7 | 2.7 | 2.8 |
| **Total solids (%)** | plastic cup | 10.90 | 10.87 | 11.01 | 10.91 | 10.74 |
| | carton tetrapack | 10.94 | 10.93 | 11.0 | 11.10 | 10.77 |
| **Nonfat solids (%)** | plastic cup | 8.10 | 8.07 | 8.21 | 8.21 | 8.04 |
| | carton tetrapack | 8.24 | 8.13 | 8.29 | 8.40 | 7.97 |
| **Acidity (°SH)** | plastic cup | 32.8 | 40.4 | 41.2 | 41.2 | 40.0 |
| | carton tetrapack | 34.0 | 40.0 | 41.2 | 40.8 | 40.4 |

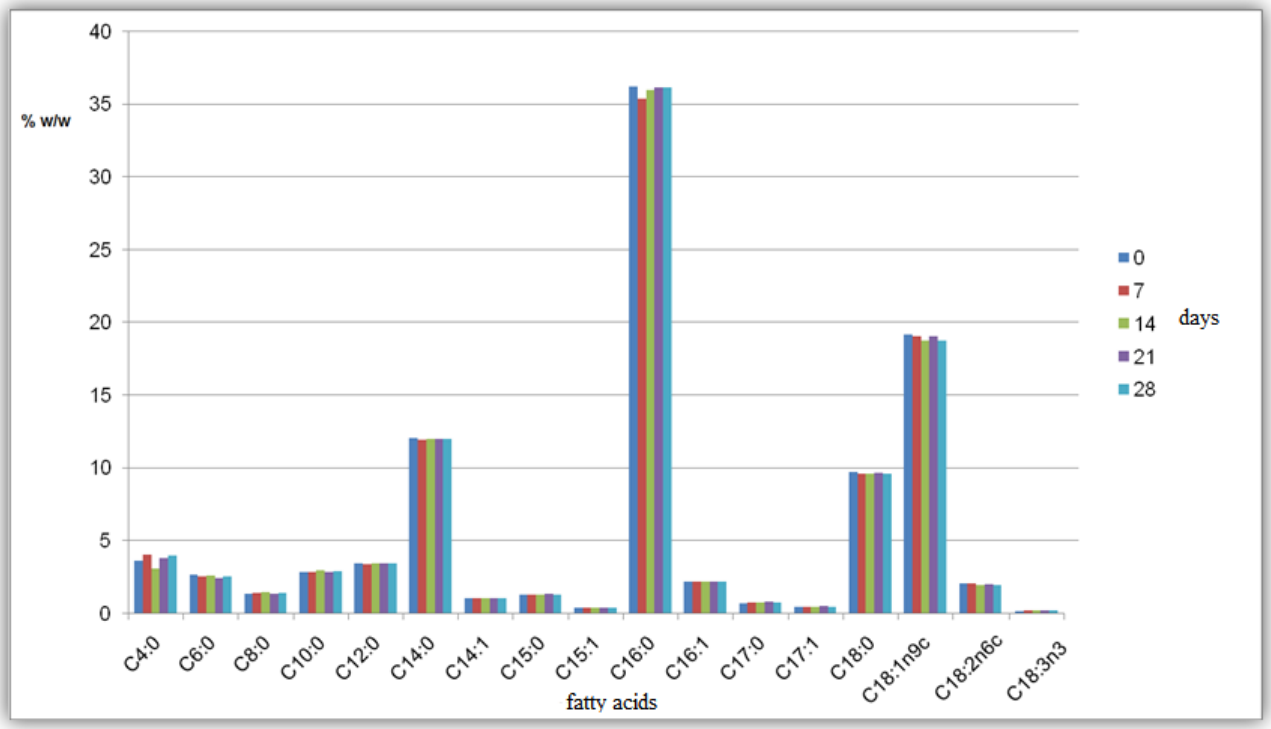


**Figure 1.** Fatty acids composition of yogurt packed in plastic cup and stored at 4°C

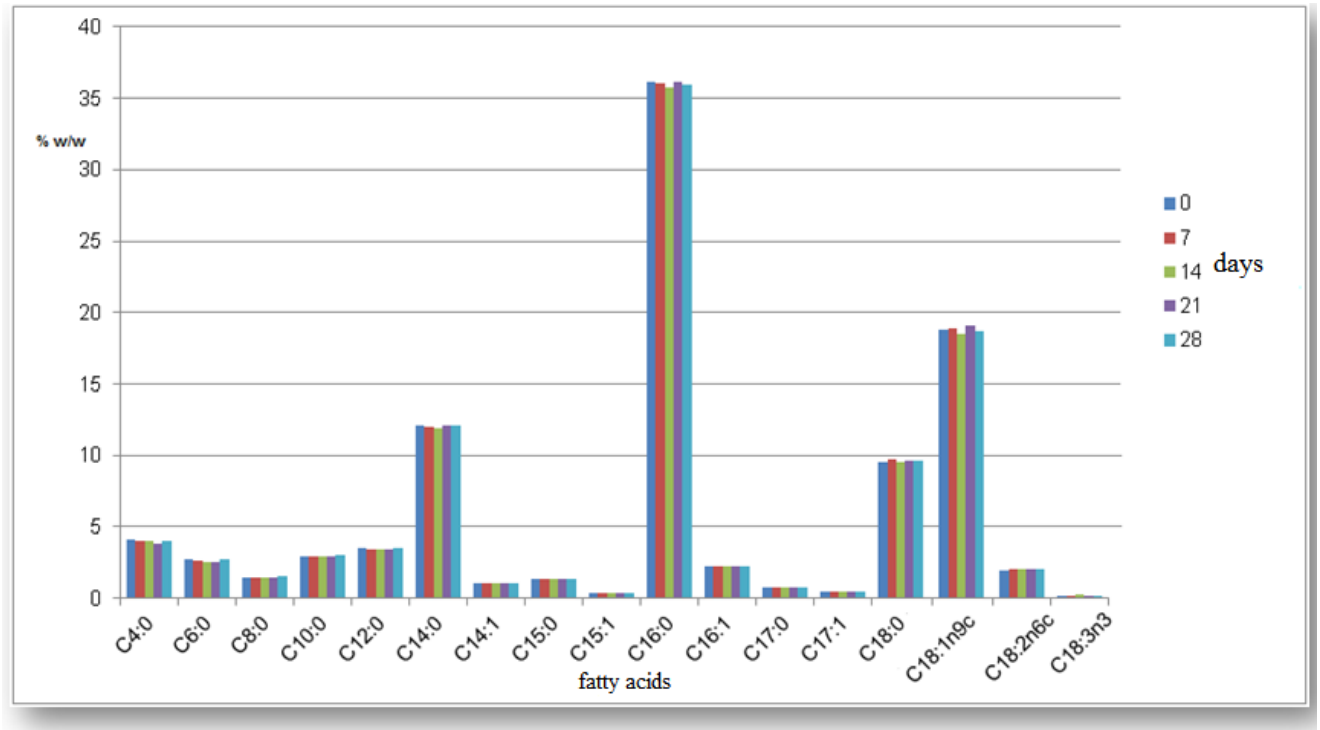


**Figure 2.** Fatty acids composition of yogurt packed in plastic cap and stored at 20°C