

EFFECT OF PACKAGING MATERIALS AND TECHNOLOGIES ON THE POTATO PRODUCTS QUALITY AT THE SHELF LIFE

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Abstract

Experiments have been carried out at the Latvia University of Agriculture Department of Food Technology and Environmental Investigations at Institute of Food Safety, Animal Health and Environment BIOR. The aim of this work was to apprise the quality changes of potato products with pork and beef which was thermally treated in vacuum packed soft retort pouches and stored at temperature $+18\pm 2$ °C. A retort pouch is a heat-resistant bag made of plastic films or foil. The quality changes of samples during storage were characterized by measuring pH, colour and microbiological parameters. Data obtained emphasize the importance of foil preventing light transparency which could provide stable quality of ready to eat products thermally treated in retort pouch for long-duration up to 6 months.

Key words: retort pouch, quality, storage, potatoes

1. INTRODUCTION

Nowadays the demand for fast and easy-to-make meals is ever increasing. This type of food is an essential dietary component of a large section of people in developed countries. Over the last few years, the development of innovative food products has been receiving an increasing attention. It is mainly because the demand for safe and easy-to-use food with extended shelf life has been increasing in both consumer and merchant groups (Valceschini, 2006). Nowadays, a significant trend has been observed in Europe: an increasing number of consumers choose for easy-to-cook foods (Olsen et al., 2012). Over the past 10 years, the market for ready-to-eat meals (referred to hereafter as MRE, i.e., meals, ready-to-eat) has increased in Europe and experienced a steady growth (Olsen et al., 2010, Oliver, Salvadori, 2012). MRE include such important features as easy use and short cooking time (Valceschini, 2006, Carini et al., 2013).

The most widely used preparation type for MRE sets is heat treatment. This type of product treatment ensures a long-term storage at room temperatures, maintaining the quality and microbiological safety (Sansone et al., 2012, Ito et al., 2014). This technology provides a number of advantages; it allows you to effectively manage the heat from the steam or water to the product through the packaging, preventing recontamination of the product. It also excludes off-flavour formation and oxidation of the product, preventing moisture and nutrient losses during evaporation and loss of volatile compounds during cooking, as well as preventing development of aerobic microorganisms in the product (Bindu et al., 2007). With an increase in demand for high quality food, one of the quality assurances includes the possibility of a new, improved and safe packaging use. Advanced packaging technologies offer new and alternative ways to protect the products from the loss of colour, flavour and nutrients, as well as the formation of off-flavours (Chen et al., 2013). Packaging is a medium between product manufacturers and consumers (Devlieghere, Debevere, 2003), packaging has a significant role in the food supply chain (Labuza, et al., 2004). The main functions of packaging are to extend the shelf life, and maintain the quality and safety of the packed goods. An effective packaging must prevent the transmission of oxygen, light and water vapour, and microbial growth to retard quality deterioration of packaged goods (López-Rubio, et al., 2004).

The retort pouch is a fast-growing packaging technology in today's consumer world. Retort pouches generally give a better product quality thanks to a shorter processing time. One example of it is the

study of Mohan et. al., founding that prawn kuruma packed in retort pouches was superior to canned product regarding to colour, firmness, chewing and overall acceptability (Mohan, et al., 2008).

Vacuum packaging prevents evaporative losses of flavor volatiles and moisture during cooking and inhibits off-flavors from oxidation (Church, Parsons, 2000) Heat treated food to reduce both the vegetative microorganisms and the spores to a safe level are called sterilization. Sterilization is typically achieved by using a pressure cooker to heat the center of the food to +250 °F (+121 °C) for 2.4 minutes (Snyder, 2006). Consumer demand for flexible pouches and plastic containers is rising, due to the growing preference for ready to eat meals and semi-cooked food products. Thus, while the market for retort pouches is currently only a niche one, it holds immense potential and opportunities for growth (Jun et al., 2006). The retortable pouch has re-emerged as a packaging alternative for both conventional and aseptically processed foods (Awuach et al., 2007). Deterioration of foods during storage is dependent from 4 general factors: enzymatic, microbial, chemical and physical processes, which could be initiated in retort processing and expand throughout storage. Several processing and storage-induced quality changes in retort pouched foods have been studied and stated in the literature (Branaga, Pruskin, 1993; Olivas et al., 2002; Rodriguez et al., 2003). Colour is one of the main factors which the consumer perceives as the quality indicator of the product (Suryawanshi, 2008). Potatoes and potato products are recognized as one of the main foods that may cause a significant risk of becoming infected with Clostridium species bacteria (Barker et al., 2005). Clostridium species are anaerobic spore-producing bacteria, so it is necessary to ensure effective heat treatment process to eliminate the risk of infection.

The aim of this work was to apprise the quality changes of potato products with pork and beef which was thermally treated in vacuum packed soft retort pouches and stored at ambient temperature +18±2 °C.

2. MATERIALS AND METHODS

Research was carried out during the period from September 2014 to February 2014. Product samples and physical and chemical analysis (colour, pH) were performed at the Packaging material property testing laboratory at the Department of Food Technology (Latvia University of Agriculture). Microbiological and corresponding to them expiry date were defined at the laboratory of Food and Environmental Investigations at Institute of Food Safety, Animal Health and Environment BIOR In total, two different types of samples were prepared: potatoes with pork and beef. The potatoes' produce samples used for experiment are summarized in Figure1.

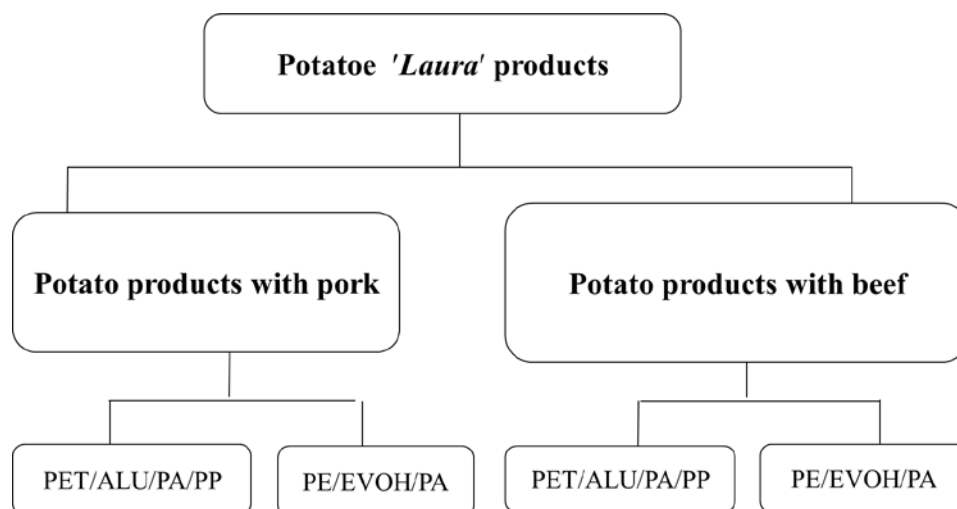


Figure 1. Structure of performed eksperiments.

Potatoes with meat were dosed in soft retort pouches made out of two different opaque packaging materials; portion mass in each pouch was 500 ± 0.05 g. Two laminated polymers with barrier properties were used: polyethylene/ethylene vinyl alcohol/polyamide (PE/EVOH/PA) and lightproof polyethyleneterephthalate/ aluminium/polyamide/polypropylene (PET/ALU/PA/PP) films. Size of each pouch was 200x250 mm, thickness of film 80 μ m. Potato products were placed in soft retort pouches, vacuum-sealed using a one-chamber vacuum packaging machine: MULTIVAC C300. It is then heat-sealed and sterilized by pressure cooking in a retort "Lagarde", sterilizing temperature $+121 \pm 2$ °C, cooling temperature $+20 \pm 2$ °C.

Samples were stored for 6 months at ambient temperature $+18 \pm 2$ °C (controlled by MINILog, Gresinger electronic) and about 40% RH. Throughout the storage period, the samples were randomly interchanged to minimize temperature fluctuations. At each time of measurement, two identical packages for each kind were randomly selected. The results were reported as averages of all determinations. Samples were analysed after thermal treatment (day 0) and following 1; 2; 3; 4; 5 and 6 months of storage.

Colour analysis. Colour of potato product samples were determined using Colour Tec PCM / PSM with CIE $L^*a^*b^*$ colour system. Measurements were completed in tenfold repetition for each sample for more precise calculations of the mean value and standard deviation. Measurements were recorded using data program Colour Soft QCW. Total colour difference (ΔE^*) of potatoes' products between initial value and after storage was calculated using the following equation 1: (Papadakis, 2000).

$$\Delta E^* = \sqrt{(L^* - L_0^*)^2 + (a^* - a_0^*)^2 + (b^* - b_0^*)^2} \quad (1)$$

where ΔE^* – total colour difference of the product during storage, L^* – colour intensity value at the final product storage day, L_0^* – colour intensity value at day 0, a^* – value of colour component green – red at the final product storage day, a_0^* – value of colour component green – red at day 0, b^* – value of colour component blue – yellow at the final product storage day, b_0^* – value of colour component blue – yellow at day 0.

Determination of pH values of the potatoes' produce samples were determined by JENWAY 3510 pH-meter using an electrode JENWAY (3 mol/KCl) (standard method ISO 1132:2001). Two identical packages were analyzed on three randomly selected locations on each sample.

Microbiological analysis. Samples for microbiological testing were prepared by standard method, LVS EN ISO 6887-1:1999 and 6887-4:2044. MAFAM – determined by standard method, LVS EN ISO 4833:2003 A; yeasts and moulds – determined by LVS ISO 21527-2:2008. To determine sulphite-reducing Clostridia in the product (Clostridium spp.), GOST standard method was used.

Data analysis. The obtained data were processed using SPSS 16.0 software package; arithmetic mean value and standard deviation were calculated. The results were analysed using univariate analysis of variance (ANOVA). Factors were rated as significant if p -value $< \alpha_{0.05}$. For the interpretation of the results it was assumed that $\alpha = 0.05$ with 95 % confidence.

3. RESULTS AND DISCUSSION

To find out the packaging material and heat treatment regime effect on the potato product quality during storage, experimentally were determined product physical properties: pH, color change, as well as microbiological assessment.

Appropriate food packaging and its properties is one of the key factors in ensuring the product quality during storage. Colour is one of the main factors which the consumer perceives as the quality indicator of the product (Suryawanshi, 2008). Generally, the colour may be affected by genetic factors and

technological parameters of production process. Technological parameters include packaging material, light exposure during storage and the type of preparation (Murcia et al., 2003). Accordingly, choosing appropriate food packaging materials can successfully extend the shelf life of the product and to maintain the original color of the product. The dynamics of potato products color L* values after the heat treatment and during the storage in both packaging materials are presented in Figure 2. The observed L* value changes of potato products has been various dependent from kind of product and used packaging materials. Significant difference of L* values of investigated samples packed in PET/ALU/PA/PP during 6 months storage was not found ($p>0.05$). The initial value of potatoes (immediately after the heat treatment) with pork colour component L* was 55.38 ± 0.8 units, which during 6 storage months increased till 55.42 ± 0.9 units, while colour component L* of potatoes with beef increases from 39.00 ± 0.7 till 39.30 ± 0.8 . Such the obtained result shows that the packaging material PET/ALU/PA/PP during storage is able to provide a color intensity constancy, which is an important factor of quality assessment.

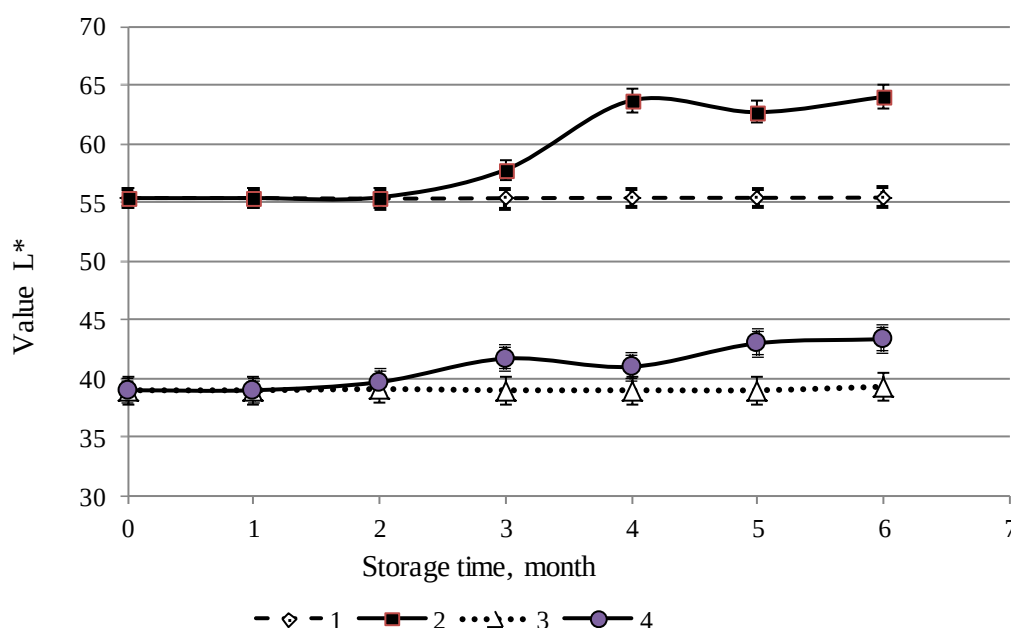


Figure 2. The changes of potatoes product samples L* values during the storage time.

1 – potatoes with pork, packed in PET/ALU/PA/PP; 2 – potatoes with pork, packed in PE/EVOH/PA; 3 – potatoes with beef, packed in PET/ALU/PA/PP; 4 – potatoes with beef, packed in PE/EVOH/PA.

Experimentally we have observed that L* values of the potatoes products samples packed in PET/ALU/PA/PP film pouches, as well as in PE/EVOH/PA bags considerably differed ($p<0.05$) after 3 month of storage. Such obtained result could be explained by the different packaging materials light transmission. By analysing the color components a* changes during storage can be concluded that in this case the packaging material is marked by a significant role in the preservation of inviolability (Figure 3).

Value a* of potatoes samples with pork packed in PET/ALU/PA/PP pouches of the six-month storage time varies from 1.60 ± 0.05 to 1.54 ± 0.06 ($p>0.05$), while samples with beef in analogue package - from 7.30 ± 0.29 to 7.05 ± 0.15 ($p>0.05$). Significant decrease in value a* ($p<0.05$) was observed after 6 months of storage in PE/EVOH/PA packaged potato products with beef from 7.30 ± 0.29 to 3.22 ± 0.12 . These significant changes occurred because PE/EVOH/PA packaging has higher light permeability.

This result indicates that the value a^* component intensity decreases and product color changes from green to greenish less.

The values of b^* meaning (-b) – blueness, (+b) – yellowness, are graphically represented in Figure. 4. The initial b^* value of potatoes with pork samples packed in PET/ALU/PA/PP pouches was 29.02 ± 0.9 units, while potatoes with beef – 31.00 ± 0.8 , which does not mutually significantly differ ($p > 0.05$) at the beginning of the experiment and during all investigated storage time, which indicates the suitability of the packaging material.

By contrast, the analysis of value b^* of potatoes products packed in PE/EVOH/PA packages, the results show that potatoes with pork b^* value changes from 29.00 ± 0.8 to 23.42 ± 0.5 , and potatoes with beef from 31.05 ± 0.6 to 20.81 ± 0.6 . Overall, the comparison of the two investigated types of packaging their effect on value b^* dynamics at the storage time significantly different ($p < 0.05$).

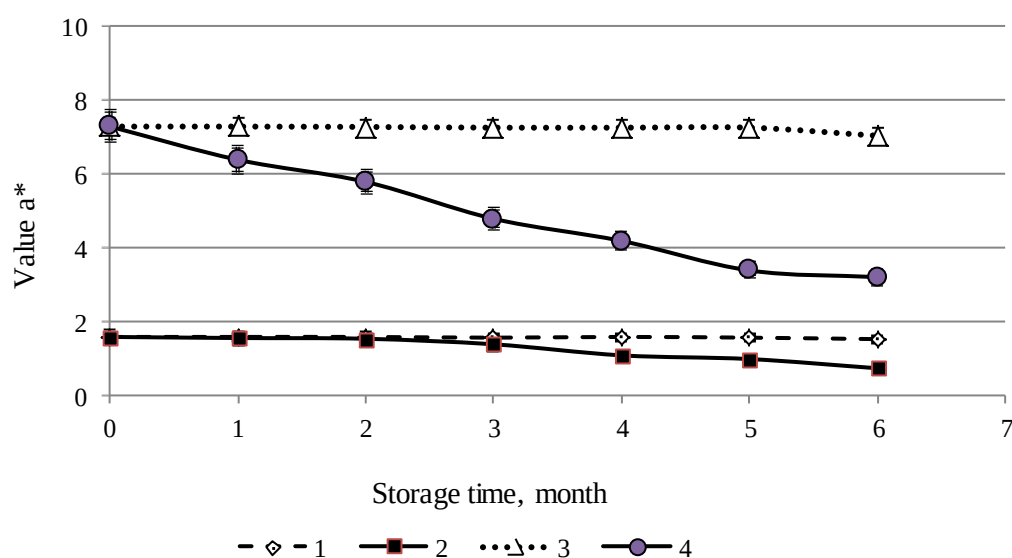


Figure 3. The changes of potatoes product samples a^* values during the storage time.

1 – potatoes with pork, packed in PET/ALU/PA/PP; 2 – potatoes with pork, packed in PE/EVOH/PA; 3 – potatoes with beef, packed in PET/ALU/PA/PP; 4 – potatoes with beef, packed in PE/EVOH/PA.

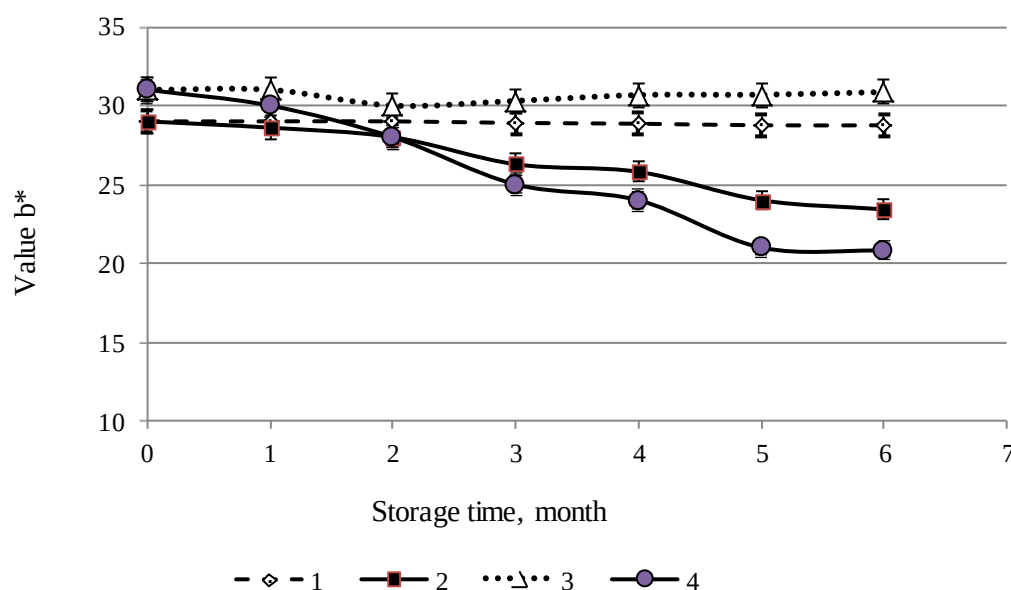


Figure 4. The changes of potatoes product samples b* values during the storage time.

1 – potatoes with pork, packed in PET/ALU/PA/PP; 2 – potatoes with pork, packed in PE/EVOH/PA; 3 – potatoes with beef, packed in PET/ALU/PA/PP; 4 – potatoes with beef, packed in PE/EVOH/PA.

To describe the product overall colour change during the storage time, the influence of packaging materials on the total colour difference (ΔE^*) has been calculated by equation (1) which is calculated from measured L^* , a^* and b^* values (Figure 5.). Total colour difference (ΔE^*) substantially differed of those samples packed in different packaging materials (PET/ALU/PA/PP and PE/EVOH/PA) during storage time, what could be explained by influence of light during storage ($p < 0.05$).

At the potato products quality important indicators should be mentioned in the product pH during storage. Significant difference in pH values among investigated potatoes' produce samples after 6 months storage was not found ($p > 0.05$), and the decrease of pH was not notable. Experimentally found that the packaging material does not affect the product pH changes during 6 months of storage (Figure 6). It can be concluded that both PET/ALU/PA/PP and PE/EVOH/PA packaging are able to provide practically constant pH during storage. This is an important indicator when assessing the possible development of microorganisms in thermally treated products in packing during storage.

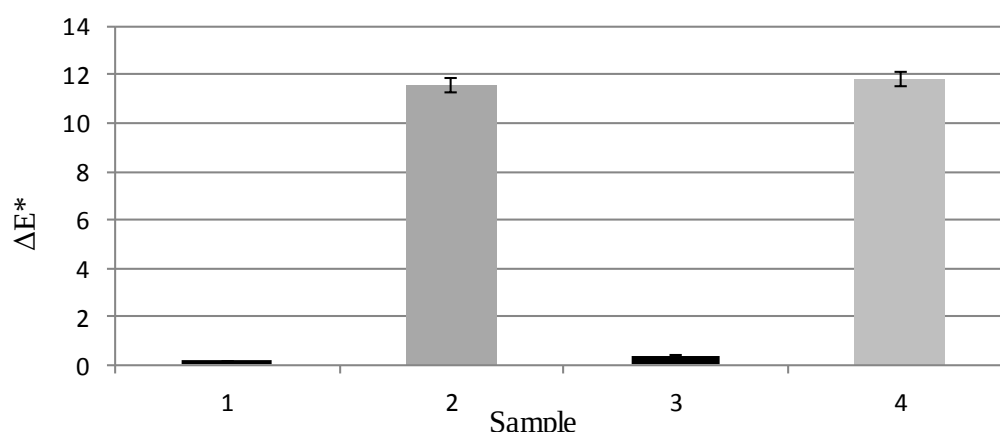


Figure 5. The total colour difference (ΔE^*) of potatoes product samples during the storage time.

1 – potatoes with pork, packed in PET/ALU/PA/PP; 2 – potatoes with pork, packed in PE/EVOH/PA; 3 – potatoes with beef, packed in PET/ALU/PA/PP; 4 – potatoes with beef, packed in PE/EVOH/PA.

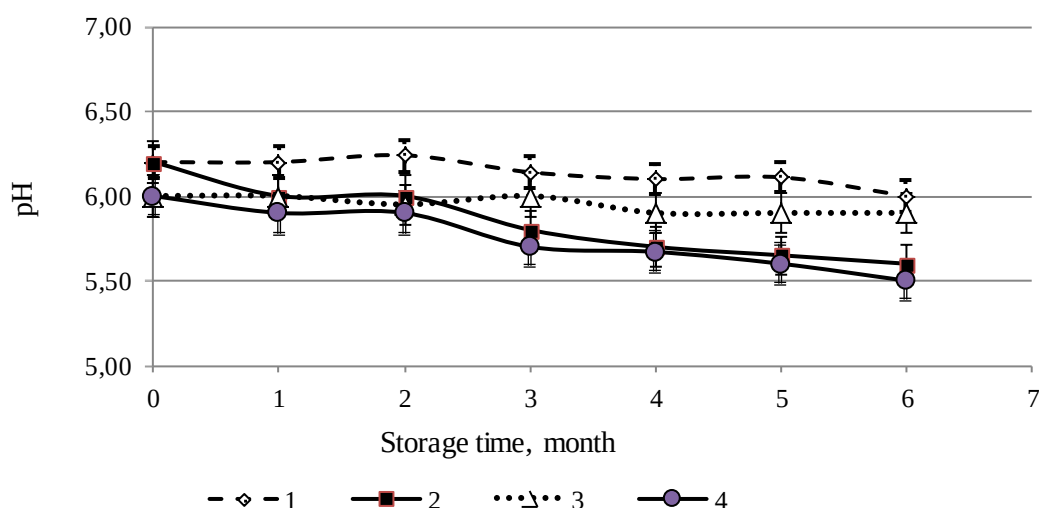


Figure 6. The dynamics of pH value of potatoes product during storage time.

1 – potatoes with pork, packed in PET/ALU/PA/PP; 2 – potatoes with pork, packed in PE/EVOH/PA; 3 – potatoes with beef, packed in PET/ALU/PA/PP; 4 – potatoes with beef, packed in PE/EVOH/PA.

Food safety is a global public health importance. Increasing variety of food -related diseases, increasing attention is being paid to food safety. One of the most common types of food contamination is biological contamination. It is relevant to emphasize the importance microbiological contamination has on public health, because direct contact and other transfer factors help microorganisms to get and proliferate in a variety of foodstuffs and the digestive tract of animals and humans. Microbiological contamination of food is one of the most common types of food contamination not only in countries where there are problems with provision of food hygiene requirements, but also in the European Union countries and the United States where a high level of consumer protection is ensured.

Total plate count and the presence of sulphite-reducing *Clostridia* were determined immediately after thermal treatment and during 6 month storage period. The total plate count (number of microorganisms) in potato products in both types of packaging materials during storage did not exceed 10 cfu g⁻¹. It clearly demonstrates that the selected treatment regimen and the choice of packaging material can ensure product safety. Sulphite-reducing *Clostridia* were not present in any of the samples during storage which indicates the effectiveness of the technology used and the ability to ensure the security and safety of the product during storage.

4. CONCLUSIONS

Changes in the total colour difference ΔE^* of potato products during 6 month storage provided that packed in PET/ALU/PA/PP are not significant ($p>0.05$), while significant colour changes have been observed in potato products packed in PE/EVOH/PA ($p<0.05$). The selected thermal treatment in vacuum packed soft retort pouches and both types of packaging materials provide microbiological safety of potato products during 6 month storage at $+18\pm 2$ °C temperature, for all that only laminated lightproof PET/ALU/PA/PP film provides constant product quality during storage. Potato products in PET/ALU/PA/PP packaging are safe for human consumption up to 6 months of storage.

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