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MICROBIOLOGICAL TESTING OF SELECTED CONFECTIONERY PRODUCTS QUALITY

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ABSTRACT

The aim of this work was to determine microbiological quality and water activity of confectionery products as corpus of desserts, stuffing cakes and finished cakes. In confectionery products microbiological parameters: total count of bacteria, coliforms bacteria, mesophilic aerobic bacteria, yeasts, microscopic filamentous fungi, counts of *Staphylococcus aureus* and *Salmonella* spp. were observed. These confectionery products were evaluated: 5 corpus of Kremeš, 5 stuffing of Kremeš and 5 Venček cake. For microbiological tests 15 samples of confectionery products were used. The numbers of total count of bacteria ranged from 2.9 to 3.65 log $CFU.g^{-1}$, the number of mesophilic aerobic bacteria ranged from 2.00 to 3.28 log $CFU.g^{-1}$, coliforms bacteria in confectionery products ranged from 0.00 to 3.15 $CFU.g^{-1}$, number of yeasts ranged from 0.00 to 3.30 log $CFU.g^{-1}$and the number of microscopic fungi ranged from 0.00 to 2.90 $CFU.g^{-1}$. None of the samples showed any growth of coliforms bacteria, *Staphylococcus aureus* and *Salmonella* spp. From microscopic fungi were isolated genera *Alternaria, Aspergillus* and *Penicillium*. Eight from fifteen investigated samples of confectionary products were in accordance with the Codex Alimentarius of the Slovak Republic. The lowest water activity was found in Kremeš corpus samples (0.953) and higher in Venček samples (0.973).

Keywords: bacteria, microscopic filamentous fungi, corpus, stuffing cakes

INTRODUCTION

Confectionery products are an integral part of the human diet because they can be used as a high density food energy source, it improves the feeling and mood of consumers, and they are an important part of celebrations, festivities and family traditions. Cakes are most popular pastry products worldwide. Cakes have sufficiently long storage time, good taste, and cake making is no long a complicated procedure. Unfortunately, cakes has high content of fat and sugar, as in result cakes are product with high content of calories, but are low in dietary fibre, vitamins, and minerals which does not respond the rules of healthy diet. The confectionery industry is one of the fastest growing segments in the global food market and this trend will be observed in the future (**Kronberga et al., 2013**).
Microbial spoilage of products is primarily limited to problems presented by yeast and mold development. This is a reflection of the low moisture and high solids content of confections (**Loureiro and Querol, 1999**). These two factors are inter-related. The high sugar content of products tends to immobilize the small amounts of water present and make it unavailable for microbial growth. In those instances where microbial activity is seen, it is usually triggered by the presence of moisture in localized areas, and in such cases yeast and mold development is most often seen. These organisms require less water than bacteria. (**Silliker, 1968**).
Spoilage problems are primarily of economic concern, since these organisms do not produce food poisoning (**Horská, 2012; Nagy et al., 2012**). However, certain molds produced by-products, mycotoxins, which cause disease when consumed by certain animals. There is increasing regulatory concern with respect to the development of mold on all types of food products. The most vexing microbiological problems in the confectionery industry have to do with consumer safety. It is not generally appreciated that microbial food poisoning is remarkably specific. Despite the thousands of different known genera of bacteria, relatively few are known to cause food poisoning, certainly, food spoilage and food poisoning cannot be equated to one another. There are four major types of microbial food poisoning. Three of these—botulism, *Staphylococcus* and *Clostridium perfringens* types–are not of concern to the confectionery industry. Growth of the causative organism in the food product is necessary, and only under the most unusual circumstance is it conceivable that any one of these three forms of food poisoning could result from the consumption of candy (**Silliker, 1968**).
Water activity plays an important role in the safety, quality, processing, shelf life, texture and sensory properties of confections. Throughout history, the importance of controlling water in food by drying, freezing, or adding sugar or salt has been recognized for preserving and controlling food quality. Most scientists recognize the importance of water activity in predicting the growth of microorganisms. However, water activity is also useful in predicting quality and shelf-life with respect to physical properties and chemical reaction rates. Water activity is the driving force for moisture migration between components or layers within a sample. Water activity also impacts physical properties such as texture, crystallization, and powder flow properties. Finally, water activity influences chemical reactivity by acting as a solvent, reactant, or changing the mobility of the reactants by affecting the viscosity of the system. Measuring and controlling water activity facilitates the development and production of high quality confectionery products that are safe and shelf stable (**Fontana, 2005**).
The present study aims at examining the microbiological quality and water activity of confectionary products sold at Slovakian private bakery a view to assessing their microbiological fitness for human consumption. In confectionery products microbiological parameters: total count of bacteria, coliforms bacteria, mesophilic aerobic bacteria, yeasts, microscopic filamentous fungi, count of *Staphylococcus aureus*, *Salmonella* spp. and water activity were observed.

MATERIAL AND METHODS

Collection of confectionery samples

The samples of confectionery products selected types were collected from Slovak private production. For microbiological analyses 5 corpus of Kremeš, 5 stuffing of Kremeš and 5 Venček cake were used. For microbiological tests together 15 samples of confectionery products were used before expiration date.

Determination of CFU counts

For microbiological analysis the confectionary samples were processed immediately after collection. The total count of bacteria (TCB), mesophilic aerobic bacteria (MAB), coliforms bacteria (CB), yeasts (Y), microscopic filamentous fungi (MF), *Staphylococcus aureus* (SA) and *Salmonella* spp. (SS) were observed. Plate diluting method was applied for quantitative CFU (Colony Forming Units) counts determination of respective groups of microorganisms in 1 g of confectionery products. Petri dishes of gelatinous nutritive substrate were inoculated with 1 mL of confectionery samples (TCB, MAB, CB, Y, MF, SA, SS) in three replications. Homogenized samples of confectionery components were prepared in advance by sequential diluting based on decimal dilution system application. For microorganism cultivation six types of cultivating mediums were used, to segregate individual microorganism groups. Plate count agar was used for CFU segregation of TCB (incubation 48-72 h at 30 °C, aerobic cultivation method). Meat peptone agar was used for CFU segregation of MAB (incubation 48-72 h at 25 °C, aerobic cultivation method). Violet red bile agar was used for CFU segregation of CB (incubation 24 h at 37 °C, aerobic cultivation method). Chloramfenicol yeast glucose agar was used for CFU segregation of Y and MF (incubation 5-7 days at 25 °C, aerobic cultivation method). XLD agar was used for CFU segregation of SS (incubation 18-24 hour at 37 C, aerobic cultivation method) and Baird Parker agar was used for Staphylococcus aureus segregation of SA (incubation 45-48 hour at 35-37 °C, aerobic cultivation method). Cultivating medium composition corresponded to producer introductions (Biomark^{TM}, Pune, India). Basic dilution (10^{-1}) was prepared as follows: 5 g of confectionery components was added to the bank containing 45 mL of distilled water. The cells were separated from substrate in shaking machine (30 minutes). Prepared basic substance was diluted to reduce the content of microorganisms below 300 CFU level.

RESULTS AND DISCUSSION

The control of raw materials, processing and environment are critical factors in the prevention of microbial contamination in confectionery. Salmonella has been found to be the major hazard in confectionery. Testing for this organism at specific control points provides the best means of quality control. Constant surveillance and good manufacturing practice are the best methods for prevention of contamination (**Kačániová and Juhaniaková, 2011**).

In Kremeš corpus samples (fig. 1) from private production the mesophilic aerobic bacteria ranged from 2.30 to 3.11 log CFU.g^{-1}. The number of the total number of bacteria ranged from 3.04 to 3.54 log CFU.g^{-1}, number of coliforms bacteria ranged from 0.00 to 2.00 log CFU.g^{-1}, number of yeasts ranged from 0.00 to 3.30 log CFU.g^{-1} and number of microscopic filamentous fungi ranged from 0.00 to 2.90 log CFU.g^{-1}. None of the samples showed any growth of *Staphylococcus aureus* and *Salmonella* spp. From the microscopic fungi were identified the genus *Alternatia, Aspergillus* and *Penicillium*. The Codex Alimentarius of Slovak republic just indicates number of coliforms bacteria (10^3) and microscopic fungi (10^2). Two samples of Kremeš corpus samples from private production were accordance with Codex Alimentarius of the Slovak Republic **(CA SR, 2009)**. Three samples were not accordance with CA SR.

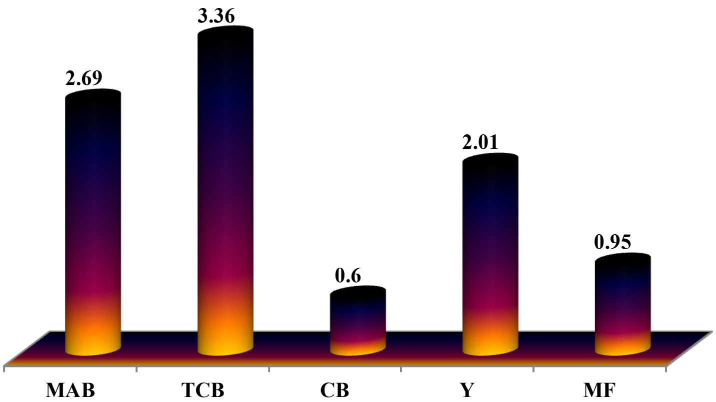

Figure 1 Microbiological quality of Kremeš corpus samples in log CFU.g^{-1}
MAB - mesophilic aerobes bacteria, TCB - total count of bacteria, CB - coliforms bacteria, Y – yeasts, MF - microscopic filamentous fungi

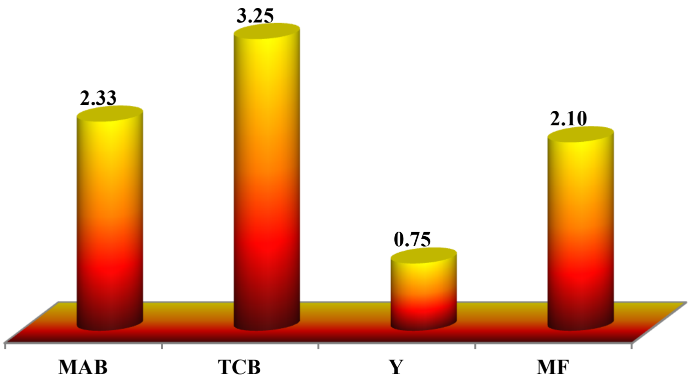

Figure 2 Microbiological quality of Kremeš staffing samples in log CFU.g^{-1}
MAB - mesophilic aerobic bacteria, TCB - total count of bacteria, Y - yeasts, MF - microscopic filamentous fungi

In Kremeš staffing samples (fig. 2) from private production the mesophilic aerobic bacteria ranged from 2.00 to 2.83 log CFU.g^{-1}. The number of the total number of bacteria ranged from 2.90 to 3.65 log CFU.g^{-1}, number of coliforms bacteria ranged from 0.00 to 3.15 log CFU.g^{-1} and number of microscopic filamentous fungi ranged from 2.00 to 2.48 log CFU.g^{-1}. None of the samples showed any growth of yeasts, *Staphylococcus aureus* and *Salmonella* spp. From the microscopic fungi were identified the genus *Aspergillus* and *Penicillium*. The Codex Alimentarius of Slovak republic just indicates number of coliforms bacteria (10^3) and microscopic fungi (10^2). Four samples of Kremeš corpus samples from private production were accordance with Codex Alimentarius of the Slovak Republic **(CA SR, 2009)**. One sample were not accordance with CA SR.

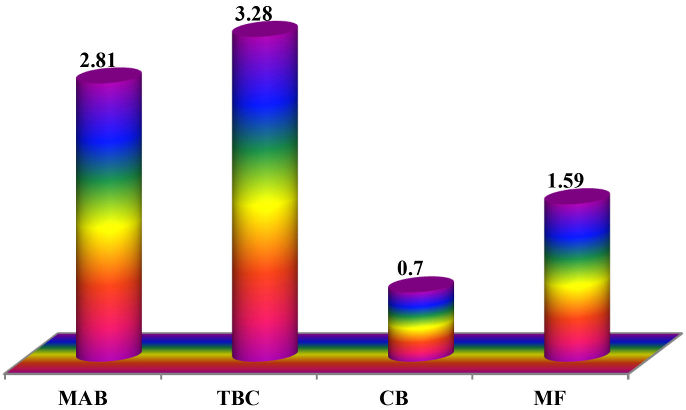

Figure 3 Microbiological quality of Venček samples in log CFU.g^{-1}
MAB - mesophilic aerobes bacteria, TCB - total count of bacteria, Y - yeasts, MF - microscopic filamentous fungi

In Venček samples (fig. 3) from private production the mesophilic aerobic bacteria ranged from 2.00 to 3.28 log CFU.g^{-1}. The number of the total number of bacteria ranged from 3.04 to 3.46 log CFU.g^{-1}, number of yeasts ranged from 0.00 to 2.48 log CFU.g^{-1} and number of microscopic filamentous fungi ranged from 0.00 to 2.48 log CFU.g^{-1}. None of the samples showed any growth of coliforms bacteria, *Staphylococcus aureus* and *Salmonella* spp. From the microscopic fungi were identified the genus *Aspergillus* and *Penicillium*. The Codex Alimentarius of Slovak republic just indicates number of coliforms bacteria (10^3) and microscopic fungi (10^2). Four samples of Kremeš corpus samples from private production were accordance with Codex Alimentarius of the Slovak Republic **(CA SR, 2009)**. One sample were not accordance with CA SR.

In the study **Juhaniaková et al., (2013)** was obtained microbiological quality of confectionary products from two different productions as were manufacture and private. The better microbiological quality of confectionary products in all followed microbial parameters were in private production. Understanding the nature of microorganisms (including their sources and growth characteristics) is key to microbial control in confectionery products. Microorganisms gain access to food-processing areas through multiple routes (e.g., raw materials, personnel and equipment traffic, water leaks and pests). Failure to implement appropriate and effective process and sanitation controls could allow these microbes, including pathogens, to become established in the processing environment where they may be able to survive for extended periods of time and re-contaminate product.

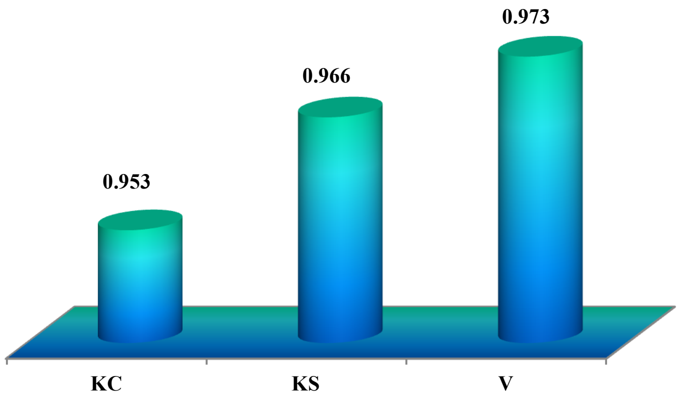

Figure 4 Water activity in samples of confectionary products
KC – Kremeš corpus, KS – Kremeš staffing, V - Venček

In fig. 4 we can see the water activity of confectionary samples. The lowest water activity was found in Kremeš corpus samples (0.953) and higher in Venček samples (0.973). Low water activity imparts microbial safety to most confectionery products. Very few intrinsic properties are as important as water activity in predicting the survival of microorganisms in a food product. Each microorganism has a limiting water activity below which it will not grow. Therefore, water activity, not water content, determines the lower limit of available water for microbial growth. Typically, most pathogenic bacteria stop growing at 0.90 except for *Staphyloccocus aureus* under aerobic conditions which grows to 0.86. The "practical" limit for yeast is 0.88, for spoilage molds is 0.70 and the absolute limit for all organisms is 0.60. Water activity also has a direct effect on the extent of sporulation, germination of spores, and toxin production (**Fontana, 2011**).
The transport of moisture into or from food materials is an important factor in controlling food quality, chemical reactions and microbial growth during storage (**Sengun et al., 2005**). One way to slow down moisture transport is to use barrier between the domains of a food material. (**Ghosh et al., 2004**).

CONCLUSION

Eight from fifteen investigated samples of confectionary products were in accordance with the Codex Alimentarius of the Slovak Republic for the microbiological properties. Microbiological quality was about the same level of all confectionary products. Water activity is a powerful tool in understanding water's impact on confectionery products. It is a key parameter for the microbial, physical, and chemical stability of confectionery products. Understanding water's impact on candy quality and how to control these impacts facilitates product reformulation, novel product development, improved product quality, and extended shelf-life. Water activity facilitates the development and production of high quality, safe, and shelf stable confectionery products with better nutritional value and healthful benefits.

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REFERENCES

CODEX ALIMENTRIUS SR 2009. - Druhá časť, Štvrtá hlava – Mikrobiologické požiadavky na potraviny a na obaly na ich balenie. 2009. [on line]. [cit. 2009-11-07]. Available at: <http://www.svssr.sk/sk/legislativa/kodex.asp>.
FONTANA, A.J. 2005. Water activity for confectionery quality and shelf-life. In Manufacturing Confectionary, 45. Available at: http://aactcandy.org/firstpage/a2005200511045.pdf.
GHOSH, V., DUDA, J.L., ZIEGLER, G.R., ANANTHESWARAN, R.C. 2004. Diffusion of Moisture through Chocolate-flavoured Confectionery. *Food and Bioproducts Processing*, 82(C1), 35–43.
HORSKÁ, E. 2012. New Consumerism and Trends at the Food Market: within and Beyond Visegrad Borders. In Horská, E. Food Sciences & Business Studies. Nitra : SPU, 2012, 410 p. ISBN 978-80-552-0815-2.
JUHANIAKOVÁ, Ľ., KAČÁNIOVÁ, M., PETROVÁ, J., KUNOVÁ, S., PAVELKOVÁ, A., BOBKOVÁ, A. 2013. Microbiological quality of confectionary products. *Journal of microbiology, biotechnology and food sciences,* 2(Special issue 1), 1244-1251
KAČÁNIOVÁ, M., JUHANIAKOVÁ, Ľ. 2011. Microorganisms in confectionary products. *Journal of Microbiology, Biotechnology and Food Sciences*, 1(1), 57-69.
KRONBERGA, M., GEDROVICA, I., KARKLINA, D. 2013. The Influence of Jerusalem Artichoke as Nutrition Value Increaser on Microbiological Parameters of Confectionery Products. 2013 2nd International Conference on Nutrition and Food Sciences IPCBEE vol.53.
LOUREIRO, V., QUEROL, A. 1999. The prevalence and control of spoilage yeasts in foods and beverages. *Trends in Food Science & Technology*, 10(11), 356-365.
NAGY, H., TÓTH, T., OLÁH, I. 2012. The role of local markets in the sustainable economic development. *Visegrad Journal on Bioeconomy and Sustainable Development,* 1(1), 27-31.
SENGUN I.Y., HANCIOGLU O., KARAPINAR M. 2005. Microbiological profile of halva sold at retail markets in Izmir city and the survival of Staphylococcus aureus in this product. Food Control 16(10): 840–844.
SILLIKER, J.H. 1968. Microbiological Problems in the Production of Confectionery and Chocolate Products. 22nd P,M.C.A. Production Conference, 1968. http://www.pmca.com/firstpage/1968_20.pdf.