



**FLORAL AND GEOGRAPHICAL ORIGIN IDENTIFICATION OF
HUNGARIAN HONEY WITH ELECTRONIC TONGUE AND
CLASSICAL ANALYTICAL METHODS**

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ABSTRACT

Honey has been widely used for health care and as sweetener since the ancient times. Due to its great nutritional value and its high price, honey is one of the most adulterated products on the market. Therefore, there is a need to develop new quick measurement methods to recognize the adulteration. Almost 80 authentic honey samples of different floral and geographical origins were collected for our experiments, focusing mainly on Hungarian honey. Various analytical methods were used for the determination of the nutritional values of the honey samples, e.g. antioxidant capacity, polyphenol content, ash content, pH, conductivity, etc. These measurements aim to complete the scarcely available data on Hungarian honeys. In addition, we determined sensory properties by color and electronic tongue analyses. Electronic tongue enables easy sample preparation and results are delivered in a short time. Evaluating the results by different multivariate statistical methods, determination of the floral and geographical origin of the samples was possible based on the results of the electronic tongue measurements. The results achieved with these classifications methods have proven by building up a robust database electronic tongue can be used for origin authentication of domestic honey samples.

Keywords: Hungarian honey, chemometrics, authentication, electronic tongue

1. INTRODUCTION

As a sweetener with high nutritional value, honey has been used since the ancient times. It is rich in biologically active compounds such as vitamins, minerals and antioxidants, organic acids, possessing

specific sensory qualities at the same time. As one of the important honey producers, Hungary is well-known for its high-quality products, considered often as reference standards [1]. Due to its qualities honey is present on the market as an important, high-priced product, which has become one of the most adulterated ones. Honey counterfeit methods range from simple addition of sugar syrups to mislabeling of floral and geographical origin. Although a wide variety of instrumental analytical methods and their combination have been developed to detect adulteration, these are often expensive and time-consuming, needing highly qualified operator [2].

Due to these limiting conditions in honey analysis, there is a continuous need for relatively cheap and simple techniques. Beside classical analytical parameters, antioxidant profile and flavor analysis can be good candidates for honey differentiation [3][4][5].

Electronic tongue can be also used as a potential method for identification of honey samples by botanical or geographical origin[6]. Various statistical analysis methods - e.g. discriminant analysis (DA) or principal component analysis (PCA) – can be employed successfully to achieve a proper classification of honeys based on the parameters measured.

2. MATERIALS AND METHODS

2.1 Honey samples

In this study 77 honey samples of different floral and geographical origin were analyzed. To ensure authenticity, honeys were collected mainly from the producers but we have some also procured some commercial products for comparison. All of the 60 Hungarian honeys are from honey producers, including samples of acacia(n=18), false indigo bush(n=4), honeydew(n=5), pine(n=2), chestnut(n=4), buckwheat(n=1), linden(n=9), linden-chestnut(n=1), raspberry(n=2), milk thistle(n=1), mustard(n=1),



Figure 1. Geographical origin of Hungarian honey samples

sunflower(n=6), canola(n=4), canola-fruit(n=2), canola-linden(n=1), bear's garlic(n=1), meadow sage(n=1), silkgrass(n=4) and multiflora(n=10) honeys. We also tested honey samples from different European and non-European origins. Hungarian honeys were collected from different parts of Hungary (Fig. 1). The samples were stored at room temperature.

2.2 Methods

2.2.1 Physicochemical properties

Classical honey analytical parameters (ash, pH, conductivity, total water soluble matter by refractometry) were determined according to the International Honey Committee [7].

Ash content

Three to seven grams of honey sample was measured to a porcelain jar and two drops of olive oil were given in each jar. Then the samples were pre-combusted with a gas burner and put in the electric furnace at 600 °C until constant weight was reached. 2 parallel measurements were applied.

pH determination

1.333 g honey sample was weighted in and dissolved in 10 ml carbon dioxide-free distilled water and measured with a pH meter. One sample had 3 parallel measurements.

Electrical conductivity

An amount of honey, equivalent to 20.0 g anhydrous honey, was dissolved in distilled water, then it was transferred quantitatively to a 10 ml volumetric flask and made up to volume with distilled water. The electrical conductivity of the solution was measured. 3 measurements were applied per sample.

Refractometry

Honeys were also analyzed using an Abbé refractometer to read their refractive index which provides information about the dry matter content of the sample using the tables of the International Honey Commission (Bogdanov, 2002). 2 parallel measurements were applied.

2.2.2 Total polyphenol content and antioxidant capacity

Sample preparation

~1 g of honey sample was diluted 10 times with distilled water and the solution used for antioxidant measurements (honey sample solution).

Spectrophotometric measurements were performed on a Thermo Helios Alpha UV-VIS spectrophotometer (± 0.001 units of absorbance), using cells of 1 cm path.

Total polyphenol content

Total polyphenol content (TPC) was determined by the Folin–Ciocalteu method, following a procedure adapted from [8]. For the test 1 ml of the honey sample solution was put in a test tube, and 7.5 ml distilled water was added. Then 0.5 ml of the Folin–Ciocalteu reagent was given to each tube and after 3

minutes 1 ml Na₂CO₃ solution was added. Absorbances were read at 750 nm after a 30-minutes incubation period in the dark. Results were expressed as mg equivalents of gallic acid (GAE) per 100 g honey.

FRAP assay

In FRAP experiments, the reduction power of honeys was estimated according to the procedure described by Benzie & Strain[9]. Briefly, the freshly prepared FRAP reagent contained 25.0 ml of 300 mM acetate buffer, 2.5 ml of 10 mM TPTZ solution in 40mM HCl, 2.5 ml of 20 mM iron (III) chloride solution. For the measurements 500 µl honey stock solution was given to 15 ml of FRAP reagent, rigorously shaken, incubated at 37 °C for an hour and then measured at 653 nm, against a blank. Results were reported as µmol ascorbic acid equivalent (ASE) /g honey.

2.2.3 Electronic tongue

The electronic tongue is designed to recognize and analyze the dissolved compounds in liquid samples. An α Astree electronic tongue (ET) [10] was applied to identify the botanical and geographical origins of honeys, The ET consist a sensor array with seven potentiometric sensors (ZZ, JE, BB, CA, GA, HA and JB) developed for food applications and an Ag/AgCl reference electrode. 9 measurements were applied per sample, with 3 repeating.

Sample preparation

10 grams of each honey sample were measured and diluted in a 100 ml volumetric flask with distilled water. The samples were tested at room temperature.

Statistical analysis

Multivariate statistical methods such as principal component analysis (PCA) and discriminant analysis (DA) were applied to evaluate the results of the electronic tongue. PCA enables recognition of the main patterns in the measurement data[11]. DA is a data-analytic tool for classification maximizes the between-class scatter and minimize the within-class scatter.). R-project was applied for data evaluation.

3. RESULTS AND DISCUSSION

3.1 Results of the classical analytical methods

These indicators, obtained in the preliminary measurements of the honey samples are used for characterization of honeys and interpretation of the results of electronic tongue.

Total polyphenol content and antioxidant capacity

The polyphenols and antioxidant capacity are important properties of honey.

According to the literature, similar values were found in honeys from the same floral origin, but significant differences were shown between honeys from distinct botanical sources. Low concentrations of polyphenols were measured in acacia and canola honeys (average: 5.0 mg \pm 0.5 GAE/100g, respectively 5.8 \pm 0,6 mg GAE/100g). Higher values were found in honeydew and chestnut honeys (average: 16.7 \pm 1.1

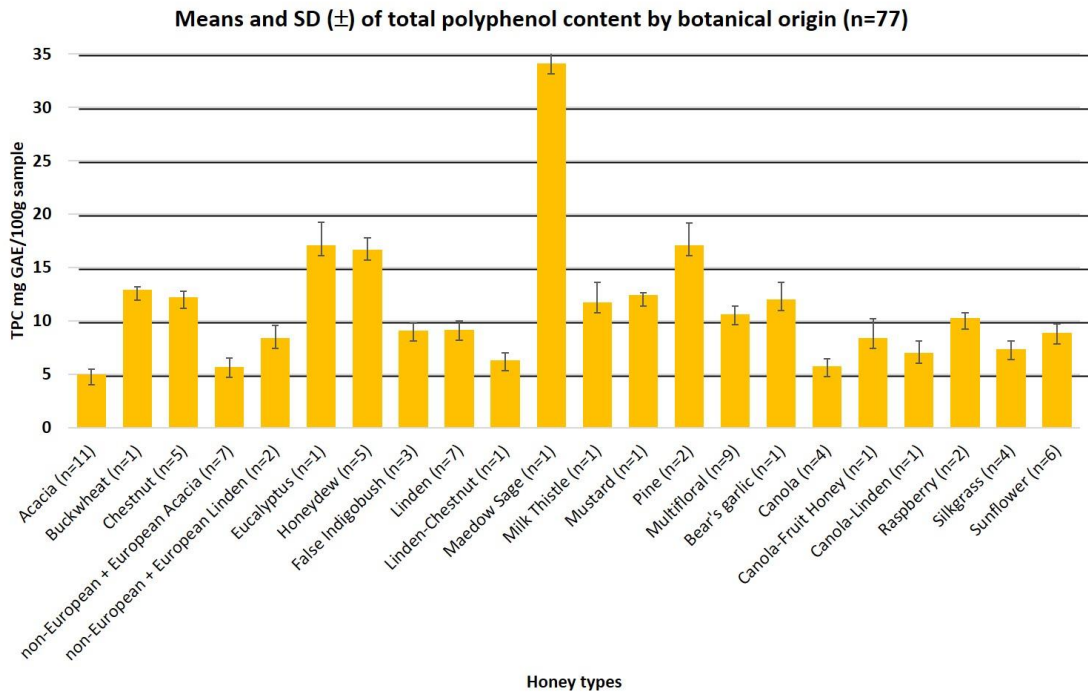


Figure 2. Average of total polyphenol content by botanical origin

mg GAE/100g, respectively 12.2 ± 0.6 mg GAE/100g) (Fig. 2) Similar trends were observed in FRAP antioxidant capacity results.

Physicochemical properties

Target physicochemical parameters used for honey characterization. The pH of the analyzed honeys was in the range 3.6-4.9, while the electrical conductivity was over $156 \mu\text{S}/\text{cm}$ in all samples, the highest values were detected in honeydew honeys (over $1000 \mu\text{S}/\text{cm}$), while acacia and canola honeys were on the other end. The ash content, which is an indicator of the mineral content, was between the range of 0.036-0.918 %, which correlates well with electrical conductivity values for the different types of honeys. As regards total water-soluble matter, the lowest values were found for milk thistle honey (78.8%) and highest in buckwheat honey (84.8%).

3.2 Results of the electronic tongue measurement

3.2.1 Principal component analysis results

The PCA results are shown in Fig. 3, the first three principal components explain 96,84% of the total variance. The data points of different floral origin honeys show some separation, acacia and linden honeys presents the two major groups.

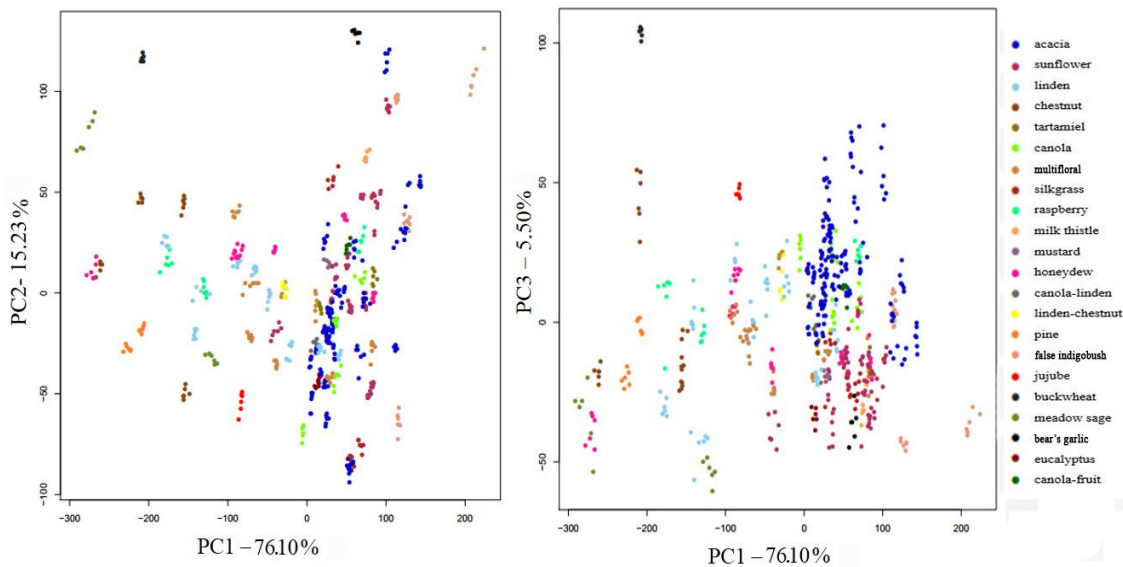


Figure 3. PCA plots of honey samples from different floral origins calculated based on the results of electronic tongue

Data points of several honeys are separated from the others, these samples also have higher values of polyphenol content and electrical conductivity.

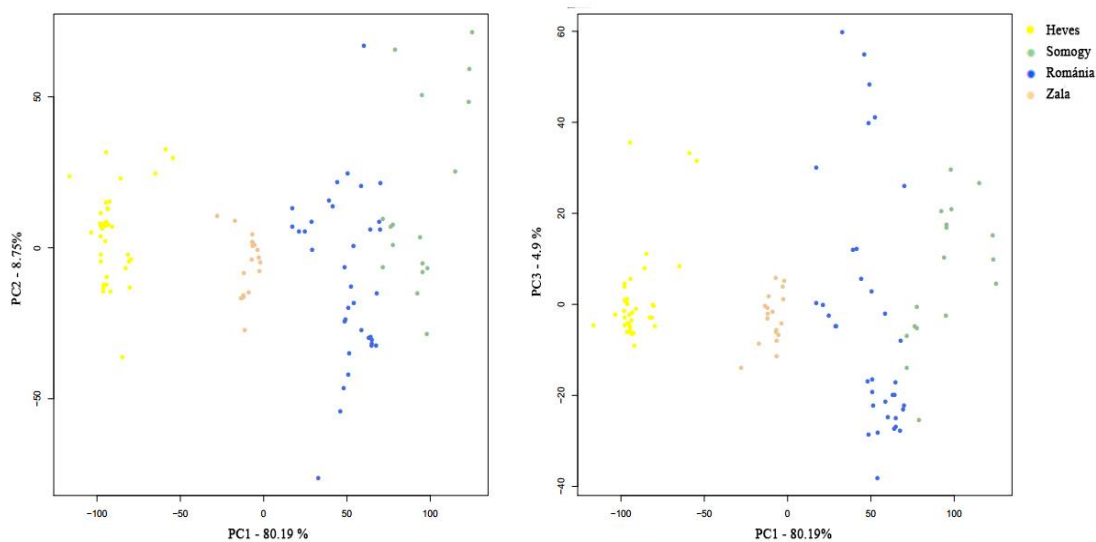


Figure 4. PCA plots for the linden honey samples from different geographical origins based on the electronic tongue

If the floral and the geographical origins were analyzed together, then the samples with different geographical, but the same floral origin were close to each other. Because of the dominance of the floral origin, the geographical origin of the samples was evaluated per floral groups. Results of PCA (Fig. 4) show that linden honey samples originating from different geographical origins present good separation.

3.2.2 Discriminant analysis results

Classification models were built for floral and geographical origin identification, respectively. Results of the achieved discrimination performance of the DA model for floral identification in training and cross-validation is shown in Table 1. The model correctly classified linden, sunflower, canola and silkgrass honey samples and presented recognition and prediction abilities of 96.3%, respectively for acacia samples misclassifying 3.7% as belonging to the group of canola samples.

The geographical origin based classification was also accurate (for example average recognition and prediction abilities were found for linden 100%), when the places of geographical origin of the honey samples were far enough from each other and climatic conditions were different.

Table 1. DA results for discriminating honey floral origin using electronic tongue

MODEL BUILDING (%)					
	Acacia	Linden	Sunflower	Canola	Silkgrass
Acacia	96.30	0.00	0.00	0.00	0.00
Linden	0.00	100.00	0.00	0.00	0.00
Sunflower	0.00	0.00	100.00	0.00	0.00
Canola	3.70	0.00	0.00	100.00	0.00
Silkgrass	0.00	0.00	0.00	0.00	100.00
MODEL VALIDATION (%)					
	Acacia	Linden	Sunflower	Canola	Silkgrass
Acacia	96.30	0.00	0.00	0.00	0.00
Linden	0.00	100.00	0.00	0.00	0.00
Sunflower	0.00	0.00	100.00	0.00	0.00
Canola	3.70	0.00	0.00	100.00	0.00
Silkgrass	0.00	0.00	0.00	0.00	100.00

4. CONCLUSION

Authentic Hungarian honeys were found to present high antioxidant activities, similarly to those described in the literature for other countries. This supports the high nutraceutical value of honey and provides new data which are lacking at the present for domestic products.

Special honeys like bear's garlic, chestnut or jujube were clearly separated from the rest of the samples based on the results of electronic tongue. The major groups such as Acacia and Linden presented also distinct patterns in the PCA maps. The results of classification showed honey samples can be differentiated according to their floral source with high accuracy. Moreover, electronic tongue enables estimation of geographical origin within the Carpathian basin, as shown for linden honeys.

The possible applicability of the electronic tongue as a single analytical tool has been proven to be useful in botanical and geographical classification of honeys.

Further exploration of the potential of this technique in classification and authentication of honeys is planned by completing the statistical evaluations with data resulting from other widely available measurement techniques, e.g. near infrared spectrophotometry (NIR), or combining with classical analytical parameters..

5. ACKNOWLEDGEMENT

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ANTIMICROBIAL EFFECTS OF THE STINGING NETTLE (*URTICA DIOICA* L.). REVIEW

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ABSTRACT

Nowadays increasing attention is being paid to herbs, one of the reasons is to avoid the undesirable side effects of synthetic drugs. This is the reason why the analysis of the antimicrobial activities of medicinal plants are increasingly in the focus of scientific experiments as well. One of the best-known medicinal plants is nettle. Among the nettle species in Hungary, Stinging nettle (*Urtica dioica* L.) can be found in the country and is most commonly utilised for medical purposes, with a focus on its leaves and roots. Nettle tea consumption is widespread in folk medicine for treating diabetes, allergies, abdominal pain, benign prostatic hyperplasia, rheumatoid arthritis and treatment of infections.

This study gives a widespread summary of the research results about the antimicrobial impact of Stinging Nettle (*Urtica dioica* L.) in the scientific literature. The papers documented a positive effect of nettle for more than 30 Gram positive and Gram negative bacterias, yeasts and fungis.

Keywords: Stinging nettle (*Urtica dioica* L.), antimicrobial effect, extraction

1. INTRODUCTION

The medicinal use of nettle as an antimicrobial became the focus of research due to infectious diseases rapidly spreading in modern societies. Antimicrobials are medicinal substances which kill living microorganisms (bacteria, viruses, fungi and parasites) or inhibit their growth or reproduction. One can distinguish the following groups of these substances based on the types of microorganisms [1], they act as:

- Antibacterials
- Antimicrobacterials
- Antivirals
- Antifungals
- Antiparasitics.

In order to examine antimicrobial properties and compounds, it is necessary to prepare various extracts.

Several methods were used to examine the antimicrobial activity of extracts. However, it would be important to select the same technology and circumstances in all cases to be able to make adequate comparisons.

Differences may occur, for example, in the following aspects:

- Where, in which geographical area and in which season has the plant been collected?
- Which part of the plant has been examined for its antimicrobial activity?
- Which extracting agent is used, for how long and at what temperature is the drug being extracted?
- What is the concentration of the prepared extract?
- Against which microorganism, at what environmental conditions are we interested in the antimicrobial activities of the herbal drug?
- Which test method is used?

No uniform test method has been elaborated yet. In the literature there is a large number of test methods, therefore it was deemed necessary to provide an analysis which compares the tests of the antimicrobial activity of nettle based on scientific research to date.

2. TEST METHODS USED TO INVESTIGATE THE ANTIMICROBIAL EFFECT OF NETTLE

The effect of antimicrobials on microorganisms is generally described by the following values: MIC = minimum inhibitory concentration, MBC = minimum bactericidal concentration and post-antibiotic effect [2]:

- MIC (minimum inhibitory concentration) is the lowest concentration of the antimicrobial which sufficiently inhibits the growth of the examined microorganism.
- MBC (minimum bactericidal concentration) is the concentration of an antibacterial agent required to kill nearly 100% of microorganisms.

These can be determined by the serial dilution method.

In the case of the serial dilution method, the test is performed in a liquid growth medium. A stock solution of the desired concentration is prepared from the compound to be tested by dissolving it in a growth medium of appropriate composition. Test tubes are incubated at 37 °C temperature for 24–48 hours (control test tubes not containing inhibitor are always used to control the growth of microbes). After the incubation, test tubes are examined with spectrophotometer. If the cloudiness of the growth medium is detected, this means that microbes were able to grow in that test tube and the analysed substance was not able to inhibit their growth in that concentration:

- The MIC value is determined by the test tube with the greatest degree of dilution (with the lowest concentration of the inhibitor) where we find clear, transparent growth medium.
- For the determination of MBC, material has to be transferred from the test tubes not showing any growth into the inhibitor-free growth medium. MBC is the concentration which does not show cloudiness even after having been transferred into the inhibitor-free growth medium.

Within the serial dilution methods, agar dilution and broth dilution methods can be distinguished.

The name of agar dilution method derives from the fact that the tested compounds can diffuse in the agar plate and they form the growth inhibition zone of tested microorganisms depending on the rate of their efficiency. Essentially, the procedure is feeding the active substance into the prepared growth medium by diffusion. The two most commonly used methods are disk and well diffusion methods:

- In the disc diffusion method paper disks impregnated with the compound of known concentration are placed on the surface of the agar plate inoculated with the tested microbes. This is then incubated for a set period of time (usually for 24–48 hours). The inhibitor diffuses into the growth medium and creates a zone of inhibition if the microorganism is susceptible to that specific agent. One can infer the efficiency of the tested substance from measuring the diameter of the zone of inhibition.
- The principle of the well diffusion method is spreading the tested microorganism into the agar plate or on its surface and cutting holes of equal diameter in the plate with cork borer tube in sterile conditions. The dilution series prepared from the solution of the tested substance is placed in the holes in equal quantities. Petri dishes are then placed in a refrigerator at 10 °C and kept there for 10 hours. They are then placed in a thermostat at 28 °C, and after 1–2 days of incubation, the diameter of the zones of inhibition or stimulation formed around the wells is measured, from which the toxicity of the active substance can be inferred.

The broth dilution method is similar to what was described in agar dilution with the difference that this is carried out on a microplate (microdilution) or in a test tube (macrodilution) in liquid growth medium and the lowest MIC is where no cloudiness can be seen in the liquid growth medium [3].

A time - bactericidal effect diagram is plotted in several cases which is obtained by showing the change in germ number in the function of time. This is primarily used to assess the joint application of more than one antibiotic as with this method it can be determined how the diagrams plotted for the separately tested antibiotics relates to that of the collective test, and whether the interaction is synergistic or additive.

A modern test method is the E-test which contains antibiotic on one side in a concentration gradient which diffuses into the growth medium and the MIC value is where the inhibition intersects the test strip [4].

3. PRESENTATION OF LITERATURE STUDIES

The biological activity of nettle extracts are probably due to secondary metabolites such as flavonoids but it is very difficult to find a chemical proof for this or to appropriately select the methods of analysis. In order to prove that the biological activity is in fact due to different chemical components in the background, exerting their medicinal effect, it is necessary to set up a chemical profile which supports the assumptions [5].

Ref. [6] examined the antibacterial and antifungal effect of *Urtica dioica* L.

- against 28 bacteria: *Acinetobacter calcoaceticus*, *A. anitratus*, *Borkholderia pseudomallei*, *Citrobacter freundii*, *Enterobacter aerogenes*, *Escherichia coli*, *Erwinia sp.*, *Klebsiella pneumoniae*, *K. pneumoniae* (ATCC 13883), *Pseudomonas aeruginosa* (ATCC 27853), *Pseudomonas stutzeri* ATCC 17588, *Salmonella paratyphi B*, *Serratia marcescens*, *Shigella boydii* ATCC 9207, *Morganella morganii*, *Streptococcus salivarius* ATCC 13419, *Yersinia sp.*, *Bacillus cereus*, *B. cereus* ATCC 10876, *Bacillus subtilis*, *Bacillus licheniformis* ATCC 14580, *Bacillus spizizenii* ATCC 6633, *Staphylococcus aureus*, *S. aureus* ATCC 12600, *S. epidermidis* ATCC 12228, *Methicillin-resistant Staphylococcus aureus (MRSA)*, *Micrococcus sp.*, *Vibrio parahaemolyticus*, 3 yeast strains: *Candida albicans*, *C. utilis*, *Saccharomyces cerevisiae* and 7 fungal isolates: *Aspergillus flavus*, *A. fumigatus*, *A. niger* USM AI 1, *Penicillium sp.*, *Rhizopus sp.*, *Trichophyton rubrum*, *Trichoderma viride*
- applying agar well diffusion and serial dilution methods.
- As a positive control, Amoxicillin was used against bacteria, while Vancomycin against *Streptococcus sp.*, Miconazole nitrate against yeasts and fungi. As a negative control, pure methanol was used.
- Disc diffusion method was used to determine the susceptibility of samples while growth medium dilution method was used for the determination of minimum inhibitory concentration (MIC).
- The extraction method was Soxhlet or sequential extraction.
- The following solvents were used for the preparation of samples: Butanol (with Soxhlet extraction), Ethyl acetate (with both extraction methods), Hexane (with Soxhlet extraction), Methanol (with sequential extraction), Chloroform (with both extraction methods). The concentration of extracts was 100 mg/l.

Ref. [7] in the analysis of the antimicrobial activity of nettle,

- used ten microorganisms: *Pseudomonas aeruginosa* ATCC 9027, *Escherichia coli* ATCC 9837, *Proteus mirabilis* (Clinical isolate), *Citrobacter koseri* (Clinical isolate), *Enterobacter aerogenes* (Clinical isolate), *Staphylococcus aureus* ATCC 6538, *Streptococcus pneumoniae* ATCC 49619, *Micrococcus luteus* (Clinical isolate), *Staphylococcus epidermidis* (Clinical isolate), *Candida albicans* ATCC 10231 nine microbes and one yeast fungus.
- the antimicrobial activity of water extract (WEN) was examined.
- As positive controls, Miconazole nitrate (40 µg per disc), amoxicillin-clavulanic acid (20–10 µg per disc), ofloxacin (5 µg per disc), and netilmicin (30 µg per disc) were used.

Ref. [8] examined the alcoholic extract of nettle leaves in their study.

- six microorganisms were used: *B. cereus* PTCC1565, *S.aureus* native strain, *K. pneumonia* native strain, *P. aeruginosa* native strain, *E.faecalis* PTCC1239, *E.coli* ATCC1533
- the solvent was water and ethanol
- within the serial dilution method, they applied the agar diffusion method
- Ampicillin and Gentamicin were used as positive controls.

Ref. [9] examined the antimicrobial activity of nettle leaves and stems

- Against two microorganisms: *Salmonella enteritis*, *Shigella dysenteriae*
- the solvent was methanol
- concentration of solutions: 11-13 mg/ml
- method: time - bactericidal activity diagram.

- Ref. [10] examined the antimicrobial activity of *Urtica dioica* leaf extract
- against five microorganisms: *A. hydrophila*, *S. typhi*, *S. aureus*, *B. cereus*, *E. coli*
- A. hydrophila* and *S. typhi* isolated from patients with food poisoning (gastrointestinal infections). The bacteria were obtained, as clinical isolates, from Al-Yarmook Teaching Hospital, Baghdad, Iraq. While, *S. aureus* isolated from the salted white cheese and *B. cereus* isolated from spoiled rice.
- solvent: 95% ethyl acetate
 - concentration of solutions: 10 mg/ml
 - within the serial dilution method, they applied the agar diffusion method
 - Cephalothin was used as positive control.
- Ref. [11] examined the antimicrobial activity of nettle leaves
- against four microorganisms: *B. subtilis* IP 5832, *E. coli* ATCC 9837, *P. aeruginosa* ATCC 9027 *L. plantarum* 299v
 - solvent: ethanol extracts in methanol dilution
 - method: macrodilution method
 - Erythromycin (E); Ampicillin (AMP); Ciprofloxacin (CIP); and Gentamicin (G) were used as positive controls.
- Ref. [12] examined the antimicrobial activity of nettle leaf, root and stem
- against five microorganisms: *L. monocytogenes* ATCC 7644, *S. aureus* ATCC 6538, *K. pneumonia* ATCC 1053, *P. vulgaris* ATCC 13315, *Candida albicans* ATCC 10231
 - solvent: 70% ethanol and water
 - concentration of solutions: 0.5-0.0625 mg/ml
 - method: agar diffusion, disc diffusion.
- Ref. [13] examined the antimicrobial activity of nettle leaf and root
- against five microorganisms: *E. coli*, *P. aeruginosa*, *B. cereus*, *MRSA*, *Enterococcus faecalis*
 - solvents: 95% ethyl acetate, 70% methanol and hot water
 - concentration of solutions: 20 mg/ml
 - method: agar well diffusion.
- Ref. [14] examined the antimicrobial activity of nettle leaf, root and stem
- against thirteen microorganisms: *B. cereus* MTCC Code:1272, *E. coli* MTCC Code:729 *Enterobacter gergoviae* MTCC Code: 621, *Klebsiella pneumonia* MTCC Code: 432, *Salmonella enterycatyphim* MTCC Code: 98, *Shigella flexneri* MTCC Code: 1457, *Staphylococcus aureus* MTCC Code: 902, *Staphylococcus epidermidis* MTCC Code: 435, *Streptococcus pyogenes* MTCC Code: 1925, *E. coli* MTCC Code: 443, *Candida albicans* MTCC Code: 3017, *Aspergillus flavus* MTCC Code: 2798, *Aspergillus parasiticus* MTCC Code: 2796
 - solvents: acetone, ethanol, ethyl acetate, chloroform, kerosene, water
 - concentration of solutions: 10mg/ml, 50 mg/ml
 - method: agar diffusion, disc diffusion method.
- Ref. [15] examined the antimicrobial activity of nettle leaf
- against six microorganisms: *E. coli* ATCC 25922, *P. aeruginosa* ATCC 27853, *K. pneumoniae* ATCC 13883, *Streptococcus pyogenes* ATCC 19615, *S. aureus* ATCC 25923 *S. epidermidis* ATCC 12228
 - solvent: water
 - concentration of solutions: 100 mg/ml

4. RESULTS IN THE PUBLICATIONS

The results in the publications investigating the antimicrobial activity of nettle were summarized in the below table. The authors used repeated experiments. The + sign shows the demonstrability of antimicrobial effect of extract in one or more publications.

In Table 1. the notations are: W=water, AC=acetone, ETAC=ethyl acetate, BU=butanol, CHL=chloroform, DE=diethyl-ether, ETH=ethanol, ME=methanol, HE=hexane, PETR=petroleum

Table 1. Results in the publications

	W	AC	ETAC	BU	CHL	DE	ETH	ME	HE	PETR
Gram-negative bacterias:										
<i>Acinetobacter calcoaceticus</i>					+	+		+		
<i>Aeromonas hydrophila</i>			+							
<i>Citrobacter freundii</i>								+		
<i>Citobacter koseri</i>	+									
<i>Enterobacter aerogenes</i>	+		+							
<i>Enterobacter gergoviae</i>	+	+	+				+			
<i>Escherichia coli</i>	+	+	+	+	+	+	+	+		+
<i>Erwinia sp</i>			+		+			+		
<i>Klebsiella pneumoniae</i>	+	+	+		+		+	+	+	
<i>Proteus sp</i>	+									
<i>Pseudomonas sp</i>	+		+				+	+		
<i>Salmonella sp</i>	+	+	+		+		+	+		
<i>Serratia marcescens</i>					+					
<i>Shigella dysenteriae</i>							+	+		
<i>Shigella flexneri</i>	+	+	+				+			+
<i>Streptococcus sp</i>	+	+	+		+		+			
Gram-positive bacterias:										
<i>Bacillus cereus sp</i>	+	+	+		+		+	+	+	
<i>Bacillus subtilis</i>				+			+			
<i>Bacillus spizizenii</i>			+		+			+	+	
<i>Enterococcus faecalis</i>			+				+			
<i>Lactobacillus plantarum</i>							+	+		
<i>Listeria monocytogenes</i>	+									
<i>MRSA sp. Methicillin-res.SA</i>			+	+					+	
<i>Staphylococcus aureus</i>	+	+	+		+		+			+
<i>Staphylococcus epidermidis</i>	+	+	+				+			
<i>Micrococcus sp</i>	+		+		+				+	
<i>Vibrio parahaemolyticus</i>			+		+				+	
Yeasts:										
<i>Candia albicans</i>	+	+	+				+			
<i>Saccharomyces cerevisiae</i>			+		+			+	+	
Fungis:										
<i>Aspergillus flavus</i>	+						+			+
<i>Aspergillus parasiticus</i>	+	+					+			+

5. CONCLUSIONS

Although the investigations are very wide-ranging, certain conclusions can be drawn, by which an image can be formed with regard to antimicrobial activities. For instance, Ref. [12] proved in the course of nettle root, leaf and stem analyses that water extracts have a greater antibacterial effect compared to ethanol extract. Stem extracts proved to be the least active. Ref. [8] showed that the ethanol extract of *Urtica* seed has the greatest effect against Gram-positive bacteria; leaf extract against Gram-negative bacteria; plant oil against fungi while the water extract practically had an antimicrobial activity against all bacteria except for *Pseudomonas*.

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LOGISTIC QUESTIONS AND SOLUTIONS AT A SPECIAL SLAUGHTER COMPANY, BECK-HÚS LTD.

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ABSTRACT

In our work, we analysed the most logistic problem of the meat production and distribution. To reach our aims, we made an interview with the manager of a meat small enterprise. There are 2 main activities, the cutting is in Csávoly (little village, near the Baja), and the producing is in Baja. We asked the manager about these main activities, their capacity, the most important products. We have got a lot of information about their partners, the terms of payments, and the main problems. We tried to make a proposal and give some advice to develop the factory.

Keywords: Logistic, Meat Production, Meat Distribution

1. INTRODUCTION

Logistic is management approach directed to planning, regulation, realization of the flow - basically materials (raw materials, semi-finished and finished products), energy, information and persons - in different systems or into them, and its aim is to reach the optimal cost of process and customer service level [1].

In other words, the notion of so-called 5R (7R, 9R) is the best known means:

Materials / products and information needed for the smooth operation of the company are required:

- in the Right Goods,
- in Right quantity,
- in Right place,
- at the Right time,
- at a Right price [2].

Logistics' corporate tasks include the following major activities:

- supply,
- production,
- distribution,
- and waste management [3].

Within these, of course, countless tasks to be solved as, e.g., in case of production: purchase, sales, internal delivery routes, conducting major information and material flows related to packaging materials, manufacturing tools, raw materials, auxiliary materials [4].

During designing corporate logistics, account must be taken of the fact that the elements closer to the sales market has a decisive role over the preventive element of the process [5].

Today's entrepreneurs also have to face new challenges, such as:

- changing economic trends
- social, political problems, disasters
- changes in customer habits and supply chain strategies
- IT developments and revolutionary new, innovative technologies
- Changes in domestic and international legislation [6]

Nowadays logistic has got important role in meat processing. Meat is a kind of fresh agricultural product. If it's not controlled properly, the quality of meat may change. In the process of storage and transportation the most important factor is the cold chain logistics [7].

On the Figure 1 we can see the common supply chain of the pork processing. In our work we analyse the some parts of the chain.

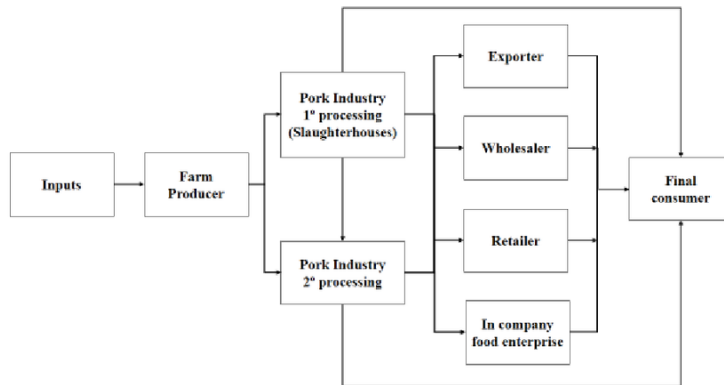


Figure 1. Pork supply chain scheme. Source [8]

Currently – we can declare – one of the symbol of the economical and financial success is the high-level controlling and logistic [9]

I indicate my aims as follows: A small of medium size slaughter enterprise has to be faced lots of problems both in logistics and other areas of the economy. I thought that I try to gain insights into the main challenges, tasks to be solved, by selecting a particular company. Recognizing the facts, I give a brief overview of these difficulties to readers. I try to find a solution to the problems, helping the selected enterprise.

2. MATERIALS AND METHODS

A personal interview was performed during the research with the General Manager of Ltd. During the interview, I was looking for answers to the questions of most important area, namely logistic, and if it was possible, for the right solutions for problems. Interview - with one of the owner as General Manager - was performed in Baja, at the company's premises.

The company has two different premises, first is at Csávoly where the pig slaughter takes place and the second is at Baja where the further processing is performed. The Company has 18 employees, 3 of them are leaders and 15 of them are physical workers. Besides the slaughterhouse and further-processing firm, the company has two butcher's shops at Baja. One of butcher's shop and the logo of company are presented in Fig. 2 and in Fig. 3.



Figure 2. Butcher's shop of BECK-HÚS Ltd. Source: [10]



Figure 3. Logo of BECK-HÚS Ltd. Source: [11]

3. RESULTS AND EVALUATION

Based on the manager's statement, I could learn about the operation line, process steps of slaughter and further processing plants, furthermore the hypothetical and real capacity and the major yield indicators.

3.1. Slaughter of pigs

Usually, the weekly number of slaughtered pigs is about 90 heads. Exceptions, if any holiday (e.g. Christmas dinner) or special long weekend is approaching by any reason. In mentioned cases they cut by 10-12 head more than usual. About 80% of pigs to be slaughtered are bought from a big breeder farm, Green2000 Ltd., while the remaining 20% is coming, from small livestock farms. The real slaughter capacity is lower than that of hypothetical capacity because of weak solvency. Remarkable problem that the possible number of pigs per truck is 30, but they has no rest area for pigs. So if they want to cut 90 pigs a week, it should mean 18 pigs (per truck) in every working day (5 days) resulting higher transport cost. They want to limit the transportation cost, so they cut pigs only on three days (but in case the slaughter firm does not work in two days). The unused cutting capacity cannot be called optimal. Weekly capacity mentioned by General Manager is about 200 pigs so the capacity utilization is about 45%. Unfortunately, no solution has been found so far to this problem, possibly, they can organize the slaughter in leasing form, but of course it's only worth to deal in case of larger quantities and regular occasions.

Of the slaughtered animals, 30 are sold in the form of halves covered with skin and the remaining 60 are boned, cut to pork cuts and processed. Weekly yield of the most important primary products coming from 60 pigs is presented in Fig. 4.

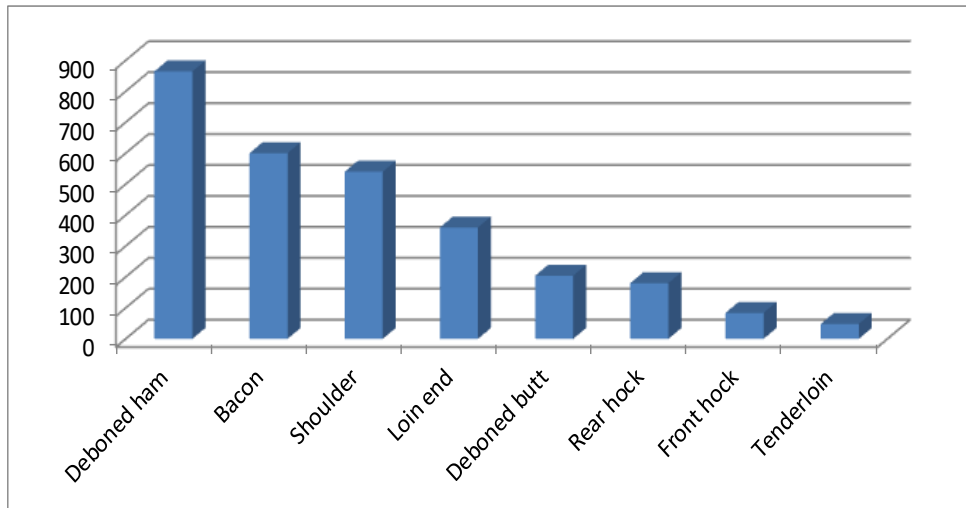


Figure 4. Weekly primary yield at BECK-HÚS Ltd. (Average; kg; Source: interview)

3.2. Further processing

Bigger part of presented primary yield is sold as carcass meat while 30-35% of all goes to further processing. We can mention that this ratio is also remarkably affected by the demand solvency.

Table 1. The ratio of different meat parts at BECK-HÚS Ltd. (%) (Source: personal interview)

<i>Meat part's name</i>	<i>Percentage of processing</i>
Loin	0
Tenderloin	0
Butt	10
Shoulder	30
Ham	60
Shoulder hock	90
Lard	100

3.3. Storage

In case of meat products, the storage of them is a very sensitive problem in the HACCP system. This firm has got more storage room as follows:

a 100 square meters cooling room for carcasses, a 40 square meters cooling room for pickled products, a 20 square meter room for raw products and a 22 square meter end product cooling room.

Listing of different storage rooms pointed that the rules and directives in meat industry need many type of storage room, using different parameters in case of different type of products. The usage of storage capacity is about 90%, actually it is not 100 percentage but better than that of the slaughter capacity usage. This high storage capacity usage explained by special reasons. First of all they hire the storage room for freezing storage of different meat parts, e.g. ear, feet freezing before Christmas holidays because Hungarian people use these parts to make a special gelled meat soup during winter season. Second case is the storage of cut raw meat for smoked, raw sausages (seasonally) and when a part of liver, lard or something else when they are not immediately processed.

3.4. Sales

The most important customers: Pécsvárad with 20 pigs per week and a processing firm in Baja with 40 pigs, their own butcher's shops of BECK-HÚS Ltd and. some of restaurants, social houses and small entrepreneurs in Baja Region who purchase meat parts for further processing aims. 40-50 partners approx. are registered at BECK-HÚS Ltd. within 50 km radius area.

In the case of entrepreneurs, the recovery of payment obligations usually was a very important problem. Nowadays, almost every entrepreneurs pay with cash, based on agreements, so the company does not have a large stock of claims, fortunately. Some larger customers as hospitals, elderly houses, schools, etc. are exceptions, they pay with bank transfer.

3.5. Suppliers

Very important aspect is the group of suppliers. The biggest suppliers was mentioned related to the slaughter. Besides this the supply with different spices, packaging media and labels is very significant.

Spices are bought from PROFOOD and ALMI-Hungary Ltds. Pickleing salt is brought from the only domestic suppliers, namely from Kalle Hungaria Ltd. The most part of different covering media as natural and artificial casings are also bought from this company, but smaller suppliers are also exists. Packaging media are brought from Szigeti and Co. Ltd, Soltvadkert, but the vacuum foils from SÁGA poultry processing company. Cervus plus Ltd. has to be mentioned because it sometimes supplements the needs of lard and meat for BECK-HÚS Ltd.

The company has old - at least 5-10 years - and well-functioning connection with their suppliers. Company take the extra quality into the focus during the selection of suppliers. It was the most difficult in case of spices because there are many suppliers and they produce many-many different mixtures with very different sensory properties. Some years ago the company have found these suppliers and their spices mixtures so the sensory properties of their products are very well balanced; actually these are optimal mixtures for BECK-HÚS Ltd. The factory pays their debts via bank transfer using 30 days deadline despite the case of living animal. The deadline is two weeks for bigger pig farms and only one week for small breeders.

4. CONSEQUENCES AND PROPOSALS

Among challenges mentioned the Introduction, general manager mentioned only the changes of customer habits which in turn is related to the economic happenings. The extent of slaughter and further processing are determined by customer demand, solvency, incomes of people and the job opportunities, stand below the counts average in this region. From the above is clear that the slaughter capacity has hidden potential so it would be better to use the slaughter activity on the rest of two days in every week for example as slaughter in leasing form. Further possibility the increase of the sale amount of carcasses parallel with more slaughtered pigs involving new markets may be in distant regions. It needs the deep evaluation of cost-effectiveness.

I heard from the General Manager that the company regularly publishes news about its sales actions in the local newspaper. It is good idea but this kind of advertising can only reach a certain audience, as many of them are thrown into the trash. In addition, it is recommended to use social media, in which different sales actions can be enhanced with impressive (appetizing) images, and the popularity of company can be enhanced with different games, etc.

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THE PART OF NÉBIH HAS IN GIVING INFORMATION AND EXAMINATION OF CONSUMER BEHAVIOUR ACCORDING TO THE RELATING POINTS

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ABSTRACT

The subjects of the research are the part of the NÉBIH has in giving information and the examination of consumer behaviour according to the relating points. The place of the research was Földeák. This is a typical settlement in county Csongrad. A questionnaire survey was completed by 152 people. Most of the answerers said that although the NÉBIH helps them orientate within news on food, it is still the family and the traditions are the factors which influence decision making even today. Regarding commercials, brief ones which are rich in information are the most popular with the answerers. More and more people check the packing of the product before buying it, and they consider the information placed on it useful. They might as well change their purchase intent because of it, though the results show that it is still people with higher education that can understand the nutrition information. Only customers with higher income can place safety and quality before price, and consumption of healthy food is pushed into the background even in case of average or under average state of health. Purchase of Hungarian products or products processed in Hungary is especially important for the age group 18-34.

1. INTRODUCTION

The choice of the subject was supported by a chapter of a book entitled „Nutrition marketing” („Táplálkozásmarketing” in Hungarian) written by Zoltán Szakály, published in 2011 [1] which lists the factors typical to the conscious costumer. The customer behaviour is connected to the work of the National Food Chain Safety Agency (NÉBIH) in several points. They intend to inform customers, to give them trustworthy pieces of information, by so doing to invite them to see value in food safety and quality, in the known origin, so in the Hungarian product, in the domestic product and in the home-processed product, which they have to pay attention to. To achieve these goals, they have to influence the customer behaviour [2] and habits [3] [4] in a way for which we can find examples in our everyday routine, like bills, advertisements, the official website of NÉBIH. It is worth having a closer look at what customers think of these things. Does the information reach them, and if so, do they use it, or do they understand it, at all?

2. A BRIEF SUMMARY OF THE RELATING LITERATURE

Concepts and research results in connection with the given subject have been summarised by a secondary research. The most important one seems to be the concept of food safety which means, according to Laczay [5], that it is ensured during the whole process of food production, storage and distribution that the food will not endanger the consumer's health if it is processed and consumed according to its purpose. The importance of the National Food Chain Safety Agency is strongly connected to this definition, how they can have part in communication with consumers. The role of information is vital since without the necessary information [6], the food purchaser and consumer makes decision without the appropriate information the basic cases of which are the following:

1. The whole information on the products is not available
2. The costumer cannot integrate the available information into his/her decisions
3. The information supply of the seller and the costumer is symmetric but that of the costumer is generally less
4. The consumer decisions are generally built on assumptions [7].

Research results, which were made in May 2009 by questioning 630 people, published by Dörnyei [8] have been summarised in charts and have been used to compile our questionnaire and to make comparisons. In

his research he examined the attitude of the Hungarian population to the label use. Also, he analysed how consumers get information on the food in the framework of a non-representative survey made with voluntary, anonymous polling. We also used a part of the research completed by Zoltán Szakály and his colleagues [9] [10] further results of research by Berke and Varga [11] in which they showed what the attitude of the Hungarian consumers to advertising tools and commercials have. They completed more research using questionnaire surveys in which they focused mostly on dairy products. We are intending to show some of their results which have relevant information for our research, too. In some of their questions they asked customers what makes a good commercial. They asked open-ended questions in their questionnaire which showed that consumers – mostly women in the age-group 19-29 - prefer funny, light advertisements. However, it often distracts the attention from the real message or content.

2. MATERIAL AND METHOD

We carried out a quantitative questionnaire survey within the primary research. The questionnaire is the structured method of data collection which makes giving information both in written and oral forms possible [12]. The compiled questionnaire included open-ended and interval scale questions, also it contained ordinal scale ones, as well. Using more types of questions proved to be useful in order to get a sharper result. During the primary research 152 questionnaires were completed in Földeák, between 17 and 23 August, 2015, typically close to the two most popular groceries. Altogether, 91 women and 61 men helped our work with their opinion. We chose our answerers randomly, with total anonymity. We used Microsoft Excel to analyze the results and PSPP statistic system to examine the assumptions, mostly the Pearson's chi-squared test.

3. EVALUATION OF THE RESULTS

Hearing the name of the National Food Chain Safety Agency most of the answerers associated to control, safety and quality. The respondents evaluated on a scale how much the NÉBIH helps them to orientate with the food. The results showed that this agency helped more than 65% in a way, and only 14,14% said „no”. We compared our results with the previously mentioned Dörnyei's results made in 2009 [8]. We used three of his questions in a table form compiling our questionnaire. The table form made not only the respondents' work easier but it was also useful in the evaluation.

We got similar results – the order was almost identical – in connection with how customers/consumers get information about food. More than 60% of the respondents get information on food from their families and friends. Traditions and customs are of great importance even today but more and more people have a look at the package of the product before buying it. Scientific forums and salesrooms are in the last place.

There was not a significant difference with Dörnyei's conclusions [8] in connection with the product information either. 45% of the answerers said that they more or less know which product is worth buying on the basis of nutrition information, and that these pieces of information help their decisions. The respondents would clearly prefer that there should be more nutrition information and this kind of information is absolutely useful. However, they could not wholly agree that they can interpret the information read or heard on nutrition.

We made the following conclusions from the aspect of the marking content. Most of our answerers do not necessarily agree with the statement that they would never change their mind on the basis of the information written on the product and 41% of them do not always read the content written in „small letters” on the product. More than 40% of the respondents think that numbers and values do not help to choose the most appropriate item. However, in case of figures and symbols there were different opinions. Most of the answerers say that it is not enough to read the product label only once to remember what was written on it and they also think that most of the time it is hardly legible. Dörnyei's results [8] are different. In approximately similar rate, the product category and the time available are important factors for our answerers to consider whether they should bother with the label or not.

In the above-mentioned research made by Berke and Varga [11] seven features proved to be the most popular in case of a good commercial. From the aspect of giving information, it seemed to be crucial to examine which are the commercials the consumers/costomers pay attention to. The respondents in Földeák preferred the meaningful, brief, informative, honest, trustworthy and real advertisements. So it may be concluded that only these types of ads are the ones that can reach them.

Our assumptions were the following:

Among consumers with different financial backgrounds asked by us only those with higher income regard safety and quality more important than price.

This hypothesis turned to be correct. More customers with higher income chose this option, altogether 24,24%. By means of chi-squared test we examined whether there is a connection between the financial background and the given influencing factors. The significance level is 0,03. Since this value is under 0,05, the counter-hypothesis, which shows a clear connection, can be accepted.

Consumption of healthy food is important only for consumers who consider their state of health average or under average.

It was not proved. We examined the results with crosstabs and we saw that consumption of healthy food is essential for 35% of answerers with average or lower state of health, while for more than 40% of above the average. We carried out the Pearson's chi-squared test. The significance level is 0,14, so the null hypothesis regarding the lack of connection can be accepted.

Only those with higher education of the respondents can interpret the heard and read information on nutrition.

The hypothesis was accepted because 43,33% of the answerers with college or university or higher degree agreed with the statement that they can generally interpret the information heard or read about nutrition. The Pearson's chi-squared test resulted in the significance level of 0,01, so it can be concluded that there is a connection between the two variables.

The National Food Chain Safety Agency helps consumers of Földeák to get the necessary information on food.

The hypothesis proved to be correct. About 40% of the answerers think that the National Food Chain Agency give a lot of help. Only around 30% said that the agency does not or just hardly helps with the information.

Respondents above 65 pay a special attention to buy Hungarian, domestic or home-processed products.

This assumption was not accepted. We can conclude that only 9,52% of respondents above 65 prefer buying Hungarian, domestic or home-processed food. However, the age groups 18-24 and 25-34 are more consciously choose these kinds of products. I examined the connection between the two variables with the Pearson's chi-squared test which resulted in accepting the null hypothesis saying that there is no connection of this kind between the age and such products.

4. CONCLUSIONS

The evaluation of the primary research showed that the NÉBIH helps consumers/costomers a lot to get information, however, 31 answerers could not answer what the first thing that comes into their mind of it. Communication with consumers is very important the first place of which is the advertisement. Our respondents clearly stated their preferences on commercials. A meaningful, informative, brief and trustworthy commercial would be the proper tool to promote safe, quality food. Observation of markers and product information is getting more popular but still only people with higher education can understand them since these pieces of information include chemical components and numbers and are not always legible. The respondents, depending on their financial background, tend to place the product price before quality, safety and health. Among our answerers it is mainly the age group 18-34 that considers buying Hungarian, domestic or home-processed products important. We continued the research with a much bigger sample already.

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THE PART OF NÉBIH HAS IN GIVING INFORMATION AND EXAMINATION OF CONSUMER BEHAVIOUR ACCORDING TO THE RELATING POINTS

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ABSTRACT

The subjects of the research are the part of the NÉBIH has in giving information and the examination of consumer behaviour according to the relating points. The place of the research was Földeák. This is a typical settlement in county Csongrad. A questionnaire survey was completed by 152 people. Most of the answerers said that although the NÉBIH helps them orientate within news on food, it is still the family and the traditions are the factors which influence decision making even today. Regarding commercials, brief ones which are rich in information are the most popular with the answerers. More and more people check the packing of the product before buying it, and they consider the information placed on it useful. They might as well change their purchase intent because of it, though the results show that it is still people with higher education that can understand the nutrition information. Only customers with higher income can place safety and quality before price, and consumption of healthy food is pushed into the background even in case of average or under average state of health. Purchase of Hungarian products or products processed in Hungary is especially important for the age group 18-34.

1. INTRODUCTION

The choice of the subject was supported by a chapter of a book entitled „Nutrition marketing” („Táplálkozásmarketing” in Hungarian) written by Zoltán Szakály, published in 2011 [1] which lists the factors typical to the conscious costumer. The customer behaviour is connected to the work of the National Food Chain Safety Agency (NÉBIH) in several points. They intend to inform customers, to give them trustworthy pieces of information, by so doing to invite them to see value in food safety and quality, in the known origin, so in the Hungarian product, in the domestic product and in the home-processed product, which they have to pay attention to. To achieve these goals, they have to influence the customer behaviour [2] and habits [3] [4] in a way for which we can find examples in our everyday routine, like bills, advertisements, the official website of NÉBIH. It is worth having a closer look at what customers think of these things. Does the information reach them, and if so, do they use it, or do they understand it, at all?

2. A BRIEF SUMMARY OF THE RELATING LITERATURE

Concepts and research results in connection with the given subject have been summarised by a secondary research. The most important one seems to be the concept of food safety which means, according to Laczay [5], that it is ensured during the whole process of food production, storage and distribution that the food will not endanger the consumer's health if it is processed and consumed according to its purpose. The importance of the National Food Chain Safety Agency is strongly connected to this definition, how they can have part in communication with consumers. The role of information is vital since without the necessary information [6], the food purchaser and consumer makes decision without the appropriate information the basic cases of which are the following:

1. The whole information on the products is not available
2. The costumer cannot integrate the available information into his/her decisions
3. The information supply of the seller and the costumer is symmetric but that of the costumer is generally less
4. The consumer decisions are generally built on assumptions [7].

Research results, which were made in May 2009 by questioning 630 people, published by Dörnyei [8] have been summarised in charts and have been used to compile our questionnaire and to make comparisons. In

his research he examined the attitude of the Hungarian population to the label use. Also, he analysed how consumers get information on the food in the framework of a non-representative survey made with voluntary, anonymous polling. We also used a part of the research completed by Zoltán Szakály and his colleagues [9] [10] further results of research by Berke and Varga [11] in which they showed what the attitude of the Hungarian consumers to advertising tools and commercials have. They completed more research using questionnaire surveys in which they focused mostly on dairy products. We are intending to show some of their results which have relevant information for our research, too. In some of their questions they asked customers what makes a good commercial. They asked open-ended questions in their questionnaire which showed that consumers – mostly women in the age-group 19-29 - prefer funny, light advertisements. However, it often distracts the attention from the real message or content.

2. MATERIAL AND METHOD

We carried out a quantitative questionnaire survey within the primary research. The questionnaire is the structured method of data collection which makes giving information both in written and oral forms possible [12]. The compiled questionnaire included open-ended and interval scale questions, also it contained ordinal scale ones, as well. Using more types of questions proved to be useful in order to get a sharper result. During the primary research 152 questionnaires were completed in Földeák, between 17 and 23 August, 2015, typically close to the two most popular groceries. Altogether, 91 women and 61 men helped our work with their opinion. We chose our answerers randomly, with total anonymity. We used Microsoft Excel to analyze the results and PSPP statistic system to examine the assumptions, mostly the Pearson's chi-squared test.

3. EVALUATION OF THE RESULTS

Hearing the name of the National Food Chain Safety Agency most of the answerers associated to control, safety and quality. The respondents evaluated on a scale how much the NÉBIH helps them to orientate with the food. The results showed that this agency helped more than 65% in a way, and only 14,14% said „no”. We compared our results with the previously mentioned Dörnyei's results made in 2009 [8]. We used three of his questions in a table form compiling our questionnaire. The table form made not only the respondents' work easier but it was also useful in the evaluation.

We got similar results – the order was almost identical – in connection with how customers/consumers get information about food. More than 60% of the respondents get information on food from their families and friends. Traditions and customs are of great importance even today but more and more people have a look at the package of the product before buying it. Scientific forums and salesrooms are in the last place.

There was not a significant difference with Dörnyei's conclusions [8] in connection with the product information either. 45% of the answerers said that they more or less know which product is worth buying on the basis of nutrition information, and that these pieces of information help their decisions. The respondents would clearly prefer that there should be more nutrition information and this kind of information is absolutely useful. However, they could not wholly agree that they can interpret the information read or heard on nutrition.

We made the following conclusions from the aspect of the marking content. Most of our answerers do not necessarily agree with the statement that they would never change their mind on the basis of the information written on the product and 41% of them do not always read the content written in „small letters” on the product. More than 40% of the respondents think that numbers and values do not help to choose the most appropriate item. However, in case of figures and symbols there were different opinions. Most of the answerers say that it is not enough to read the product label only once to remember what was written on it and they also think that most of the time it is hardly legible. Dörnyei's results [8] are different. In approximately similar rate, the product category and the time available are important factors for our answerers to consider whether they should bother with the label or not.

In the above-mentioned research made by Berke and Varga [11] seven features proved to be the most popular in case of a good commercial. From the aspect of giving information, it seemed to be crucial to examine which are the commercials the consumers/costomers pay attention to. The respondents in Földeák preferred the meaningful, brief, informative, honest, trustworthy and real advertisements. So it may be concluded that only these types of ads are the ones that can reach them.

Our assumptions were the following:

Among consumers with different financial backgrounds asked by us only those with higher income regard safety and quality more important than price.

This hypothesis turned to be correct. More customers with higher income chose this option, altogether 24,24%. By means of chi-squared test we examined whether there is a connection between the financial background and the given influencing factors. The significance level is 0,03. Since this value is under 0,05, the counter-hypothesis, which shows a clear connection, can be accepted.

Consumption of healthy food is important only for consumers who consider their state of health average or under average.

It was not proved. We examined the results with crosstabs and we saw that consumption of healthy food is essential for 35% of answerers with average or lower state of health, while for more than 40% of above the average. We carried out the Pearson's chi-squared test. The significance level is 0,14, so the null hypothesis regarding the lack of connection can be accepted.

Only those with higher education of the respondents can interpret the heard and read information on nutrition.

The hypothesis was accepted because 43,33% of the answerers with college or university or higher degree agreed with the statement that they can generally interpret the information heard or read about nutrition. The Pearson's chi-squared test resulted in the significance level of 0,01, so it can be concluded that there is a connection between the two variables.

The National Food Chain Safety Agency helps consumers of Földeák to get the necessary information on food.

The hypothesis proved to be correct. About 40% of the answerers think that the National Food Chain Agency give a lot of help. Only around 30% said that the agency does not or just hardly helps with the information.

Respondents above 65 pay a special attention to buy Hungarian, domestic or home-processed products.

This assumption was not accepted. We can conclude that only 9,52% of respondents above 65 prefer buying Hungarian, domestic or home-processed food. However, the age groups 18-24 and 25-34 are more consciously choose these kinds of products. I examined the connection between the two variables with the Pearson's chi-squared test which resulted in accepting the null hypothesis saying that there is no connection of this kind between the age and such products.

4. CONCLUSIONS

The evaluation of the primary research showed that the NÉBIH helps consumers/costomers a lot to get information, however, 31 answerers could not answer what the first thing that comes into their mind of it. Communication with consumers is very important the first place of which is the advertisement. Our respondents clearly stated their preferences on commercials. A meaningful, informative, brief and trustworthy commercial would be the proper tool to promote safe, quality food. Observation of markers and product information is getting more popular but still only people with higher education can understand them since these pieces of information include chemical components and numbers and are not always legible. The respondents, depending on their financial background, tend to place the product price before quality, safety and health. Among our answerers it is mainly the age group 18-34 that considers buying Hungarian, domestic or home-processed products important. We continued the research with a much bigger sample already.

ACKNOWLEDGEMENT

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INVESTIGATION OF MULTIVARIATE STATISTICAL PROCESS CONTROL IN R ENVIRONMENT

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ABSTRACT

At the first stage of our work, the theoretical knowledge needed to use the multivariate statistical process control (MSPC) was explored. Last year, we clarified the sometimes confused concepts, equations, and formulas [1]. At the second stage, R project simulation studies and some food industrial practical model investigations are carried out for confirming the MSPC advantages compared with the univariate ones. Furthermore, we analyse, using principal component analysis (PCA), what could cause the outlying values. Moreover, we will demonstrate how to use the MYT-decomposition.

Keywords: Multivariate statistical process control, MYT-decomposition, principal component analysis

1. INTRODUCTION

During the statistical process control (Statistical Process Control, SPC) interventions happen in a particular process of product manufacturing if we know a cause, which can affect the value of the quality characteristics (e.g., mass) in a wrong way. Among the main tools of the SPC, the control charts [2] can be mentioned.

2. METHODS

Within the statistical process control, univariate and multivariate process controlling methods can be distinguished. The main difference between these two methods is that in the case of univariate methods (Univariate SPC, USPC) a known variable is being interpreted with one or more – not artificial – variables. While in the case of multivariate methods (Multivariate SPC, MSPC) several known variables are being interpreted with fewer artificially constructed variables [3]. The Fig. 1 shows the difference between these two methods, e.g. the oblique position of the ellipse indicates the co-changing (correlation) of the variables.

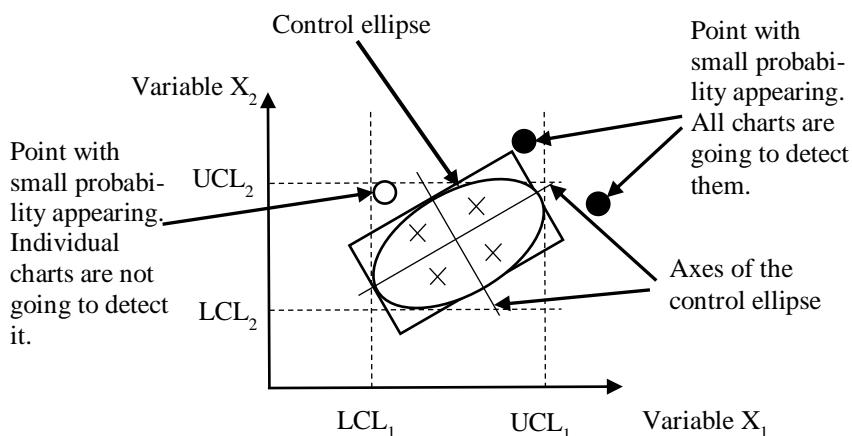


Figure 1. The comparison of univariate and multivariate methods [2]

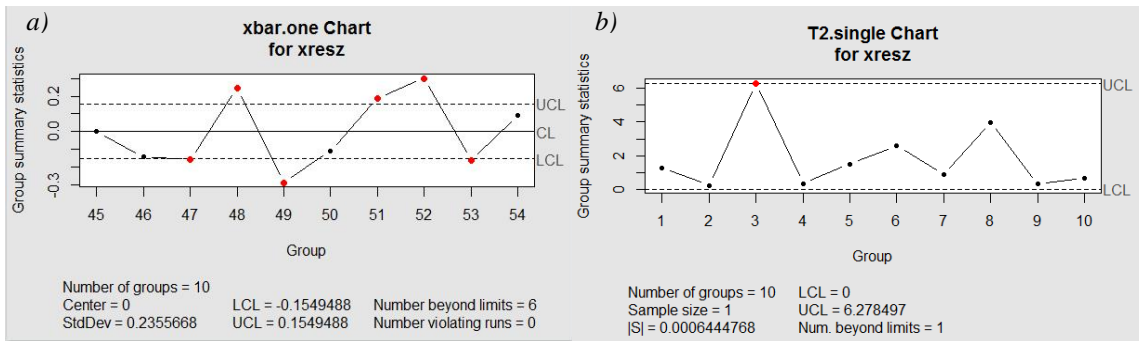


Figure 2. a) Mean-chart and b) T²-chart (with a confidence level of 95%), obtained by generating random numbers

The exact distribution of the T²-statistics ($T^2 = n(\bar{X} - \mu)'S^{-1}(\bar{X} - \mu)$) depends on two aspects [2]:

- on the one hand, it matters whether we work with individual or sub-grouped data;
- on the other hand, whether we carry out a backdated analysis for stabilisation (Phase I.) and supervise the current process for monitoring (Phase II.).

In Phase II., however, it is hard to determine what could have caused the signal's alteration from the acceptance range. Possibly it was one of the quality characteristics, or the co-changing of one or more variables, or the change of the covariance. Several methods have been developed for this problem, for example, the principal component analysis and MYT-decomposition [4]. Ref. [4] describes some examples of a special calculation scheme of MYT-decomposition.

3. RESULTS AND DISCUSSION

Last year, at the conference called 22nd International Symposium on Analytical and Environmental Problems [1], we presented the necessary theoretical knowledge for using the MSPC in a poster presentation. We made clear the types of the applicable knowledge and their roles, and we collected the main advantages and disadvantages of the application of the MSPC compared to the USPC [1].

In the second stage of our work, firstly we carried out some simulation examinations executed in the R-environment [5], which we are going to detail from now on. In the case of one of the algorithms, we made an X-bar chart (mean-chart) (Fig. 2a)), applicable as the instrument of univariate process controlling methods, by using data series obtained by generating 100 uniform distributed random numbers (with the help of the "runif"-command). The CL stands for the centre line, UCL stands for upper control limit of the acceptance range, while LCL means its lower control limit. In the Fig. 2b), we can see the T²-chart, applicable to MSPC, where the "rmvnorm"-command was used for generating random numbers.

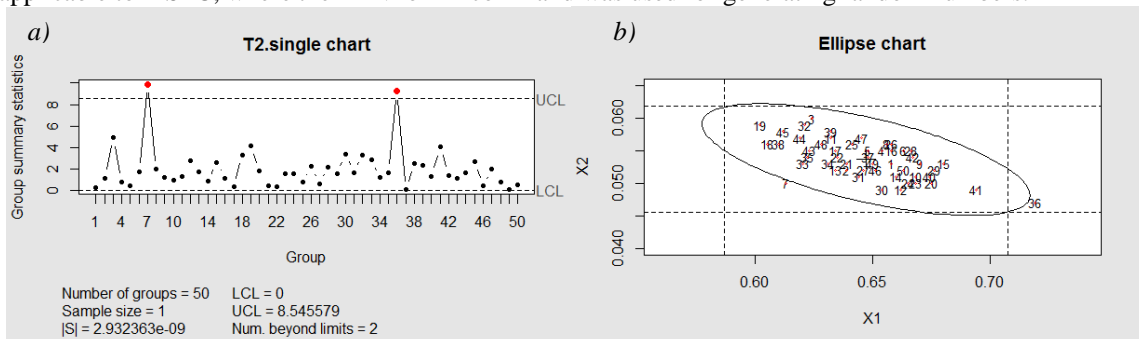


Figure 3. a) T²-chart and b) the control chart involving a control ellipse about the salt- and water-content of marinated ham, based on the example of Ref. [6] (with a confidence level of 99%)

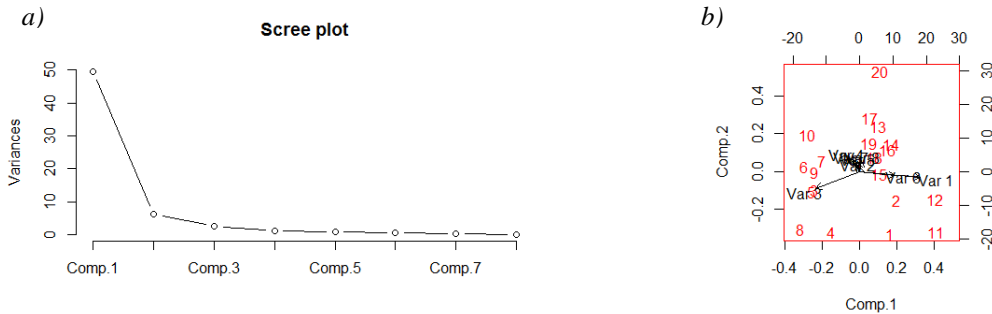


Figure 4. a) Scree plot and b) biplot in the viewpoint of the variables of the maturing of the Parma ham

After the implementation of the algorithms, the next step was the control (done in an R-project) of the measurement data published in Ref. [6] with the aim of reconstructing the Hotelling’s T^2 -chart and the control chart containing the control ellipse (Fig. 3a)).

We could reconstruct the T^2 -chart, but we did not get back the control chart containing the control ellipse like published in the referred literature [6], due to an error message: („group sizes must be larger than one”). With fixing up the source code of the command „ellipseChart”, we could finally display the control chart (Fig. 3b)).

After that, we generated illustrations of practical application to prove the advantages of the MSPC compared to the USPC. One of the practical application illustrations is the process control, presented with the use of the measurement data of the maturing process of Parma ham published by the University of Copenhagen [7]. Considering other experiences as well, it can be established that it is not necessary to mature the hams for 15-18 months from the date of the production, roughly it is enough to mature them for a year (11-12 months), at least with taking into consideration only the analytical measurement data.

After this, we examined (in R-project, with the use of the method of the principal component analysis) that from among the 8 measured variables (i.e. water-, salt- and protein-content, two organoleptic judgements, and the L, a and b parameters belonging to the colour measurement), which will have prominent impact to the process. In the scree plot (Fig. 4a)) we can see that there are three main components. With the help of the biplot (Fig. 4b)), it can be claimed that the 3rd variable (protein-content, it is an impact factor as well), the 1st and the 6th factors (water-content and the L-parameters) differ significantly from the other six variables.

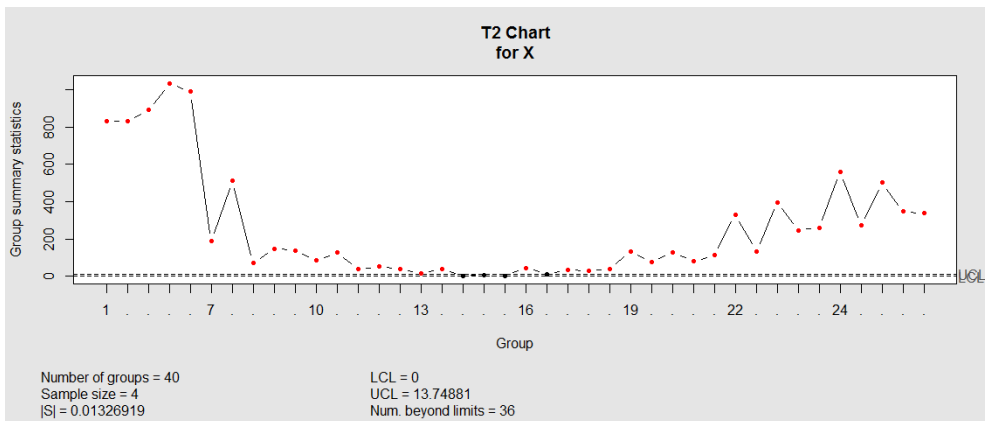


Figure 5. Process tracking in the viewpoint of the variables of the maturing of salami (with a confidence level of 95%)

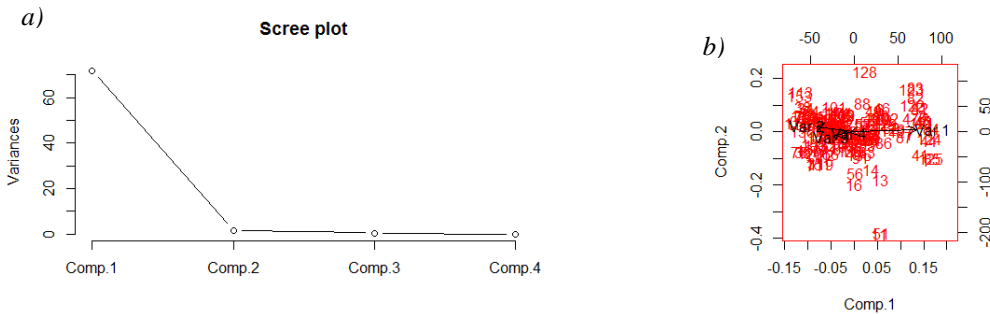


Figure 6. a) Scree plot and b) biplot in the viewpoint of the variables of the maturing of salami

The other practical application illustration was the process tracking of the curing of a private label salami, whose measurement data we thank Csaba Rostás and his supervisor, Ferenc Eszes.

In the Fig. 5, the parts of the curing of the salami can be easily distinguished:

- re-moistening and softening of the crust happened in the first days after the smoking,
- the drying of the product started with the 7th day,
- from the 10th day to the 19th the curing of the salami stabilised
- then dehydration happened again with ending the stable process.

Furthermore, in the scree plot (Fig. 6a)), we can see that there are two principal components. The biplot (Fig. 6b)) indicates that the first variable and the second variable (the variables were declared confidential by the private company) differ strongly from each other and the other quality characteristics.

Lastly, we are going to present an example of the application of MYT-decomposition, or in other words, we are going to find the answer to the question that what could cause the signal’s alteration from the acceptance range. For this we used the T²-statistics obtained from the measurement data of Ref. [6] (the T²-chart in Fig. 3a)). In Fig. 3a), we can see that there are two outliers, these are the 7th and the 36th samples. We present the detailed calculation through the 7th sample first. Since this process control is bivariate, we can decompose the T²-value (obtained from the 7th sample) in two ways [4]:

$$T^2 = T_1^2 + T_{2,1}^2 \tag{1}$$

$$T^2 = T_2^2 + T_{1,2}^2 \tag{2}$$

The value of the 7th sample is 9,888, and the upper control limit (UCL) is 8,546, so it can be seen that the T²-value exceeds the UCL. Thus, it is necessary to calculate the unconditional T²-values (T₁² and T₂²) with a new upper control limit. We summarise these values in Table 1.

The values of Table 1 show that the unconditional T²-values fall within the acceptance range (their value is lower than the value of UCL), therefore we have not found the cause of the fault indication yet.

Table 1. Unconditional T²-values and the UCL value belonging to them

T_1^2	T_2^2	UCL
2,038	1,544	7,326

Table 2. Conditional T^2 -values and the UCL-value belonging to them

$T^2_{2,1}$	$T^2_{1,2}$	UCL
7,850	8,344	7,491

Thus, we have to calculate the conditional T^2 -values (with the help of the equation (1) and equation (2)), and the upper control limit, which we summarise in Table 2.


Since the conditional T^2 -values exceed the upper control limit, the signal's alteration from the acceptance range in the case of the 7th sample happens, because the correlation of the water- and salt-content does not follow the one observable for the other measurement points.

4. CONCLUSIONS

In this article, we presented the simulation examinations developed in an R-project, and the practical application methods, with which we illustrated the advantages of the MSPC compared to the USPC. However, it is important to notice that these measurement data are not designed for process control (both in the case of the process tracking of Parma ham and privately labeled salami). We also investigated on published data what caused the signal's alteration from the acceptance range in the Phase II., for which we can use principal component analysis or the so-called MYT-decomposition.

Our aim, in the future, is to perform the control of a specific technological process in practice, with the help of an industrial partner, for which we have to develop an optimal experiment plan as well.

5. ACKNOWLEDGEMENTS

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OPERATING STUDY OF MICROWAVE TREATMENT SYSTEM USING DESIGN OF EXPERIMENT TECHNIQUE

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ABSTRACT

This paper presents the findings of an experimental investigation into the effects of irradiation power (PM), flow rate (FR), and treating number (NT) in anaerobic digestion of food industrial wastewater. A two-level factorial experiment has been used to accomplish the objective of the experimental study. The specific energy demand (SED) of microwave treatment was the response variable investigated. The experimental results indicate that the proposed mathematical models suggested could adequately describe the performance indicators within the limits of the factors that are being investigated.

Keywords: wastewater pre-treatment, biogas, microwave, anaerobic digestion

1. INTRODUCTION

Population growth, increasing living standards, but also environmental hazards with global climate change as the most significant are all contributing to an increasing water general demand and stress in many parts of the world. While access to fresh water for drinking water is getting more costly, uses of drinking water for agricultural and industrial use, which are in need of substantial water quantities, is a major problem. In addition as the general demand for water is growing, the amount of waste water produced and the pollution load are continually increasing. Despite its growing volume, sewage is also a reliable source of alternative water source if it can be recycled and resource can be recovered. In this sense sewage can be a cost-effective and sustainable energy source and it may also contain nutrients, organic substances and other useful by-products. From this point of view wastewater is no longer a problem that requires a solution but rather a solution to the challenges that society faces today. [8]

The chemical, thermal and hydraulic energy contained in wastewater can be recovered in the form of biogas, heating/cooling and electricity generation through on-site (in wastewater treatment plants) and off-site (in centralized plants) processes [2].

Biogas production from chemical energy contained in organic substances in wastewater through the anaerobic digestion of biosolids for subsequent electricity and heat generation is the most common application of on-site energy recovery. Biosolids in wastewater mainly comprised of microbial cells and extracellular polymeric substances (EPS) produced by the cells as part of their metabolic activity. The microbial cells and EPS form a matrix that is the substrate for the anaerobic digestion. With respect to their physical state, microbial cells represent a relatively unfavourable substrate for subsequent microbial degradation. A large part of the organic matter is compartmentalized within the microbial cell membranes. This microbial cell wall is a semi-rigid structure which provides sufficient intrinsic strength to protect the cell from osmotic lysis. It contains glycan strands cross-linked by peptide chains that give the walls resistance to biodegradation. Because of this, conventional biological digestion techniques require long hydraulic retention times. To improve digestion efficiency, the most logical approach is to disrupt the microbial cells in the sludge, to make the organic material inside the cell walls available [7]. The pre-treatment also has the goal of decreasing the particle size, allowing a greater surface area per unit volume available for degradation [6]. Disintegration may be performed by chemical, thermal, mechanical, or the combination of the previous techniques. The application of microwaves (MW) is one of the pre-treatment techniques. Additionally, it was reported that biogas production increased with the application of microwaves and that it was higher than the gas production obtained in tests subjected to the same temperature but with conventional heating. [1] Microwave pre-treatment is an energy-intensive and

therefore cost-intensive technique, so it is important to set the optimal operating parameters of the treatment. The optimization techniques of treating parameters through experimental methods and mathematical and statistical models have grown substantially over time to achieve a common goal of improving the process efficiency. To construct an approximation model that can capture interactions between n design variables, a full factorial approach may be necessary to investigate all possible combinations [3]. The experiments were conducted using two-level fractional factorial experiments while the statistical analysis was concluded in the form of analysis of variance (ANOVA). Other experimental design approaches commonly utilized for modelling responses are the Taguchi technique and response surface methodology (RSM).

2. MATERIALS AND METHODS

Wastewater was collected in a Hungarian medium-sized meat processing company; the sampling point was after the grease trap. Sewage originates from meat processing technology, mainly from the flushing and rinsing process of equipment (slicing and packaging machines, smoking chambers). To remove grit, particles and other large-sized solids a cloth filter was used. Table 1.

Pre-treatment was carried out in a continuous flow microwave treating system developed at University of Szeged. (Fig 1) It contains a water-cooled, variable-power magnetron (M) operating at 2450 MHz. High-voltage power supply (NF power supply) feeding the magnetron consists of two transformers, one of them produces cathode heating voltage and heating current, the other produces the anode voltage which can be controlled by the primary circuit of an external auto-transformer. With this device (PM scaled TTR) the power of the magnetron can be set as well. Electromagnetic energy of the magnetron spread over a resonant slot. Getting through this slot the energy gets in the toroidal resonator. [5]. During the operation of toroid resonator energy is given to the treated material. Material is transferred in the continues-flow microwave treating system by a peristaltic pump (PP) with variable flow.

Anaerobic digestion (AD) tests were carried out under controlled mesophilic temperature range ($35 \pm 0.2^\circ\text{C}$). in 12 mini continuously stirred laboratory scale reactors with 250 mL total volume, equipped with Oxitop C measuring system.

Pre-treatment conditions and accordingly energy demand were very different, therefore specific energy demand was determined. Due to the nature of the parameter, the lowest value is the best in terms of energetic. [10]

$$SED = \frac{E}{BP} \quad [JmL^{-1}] \quad (1)$$

where BP is biogas production [mL], E is the energy demand of pre-treatments was calculated from the power of the magnetron (P_M) [W] and the time of irradiation (t) [s].

$$E = P_M \cdot t \quad [J] \quad (2)$$

Table 1: Characteristics of wastewater

Parameter	Value
Total solid (TS) (mgL^{-1})	3210 \pm 296
Total organic carbon (TOC) (mgL^{-1})	834.1 \pm 35.3
Lipid(mgL^{-1})	115.1 \pm 21.7
Protein (mgL^{-1})	379.4 \pm 21.2

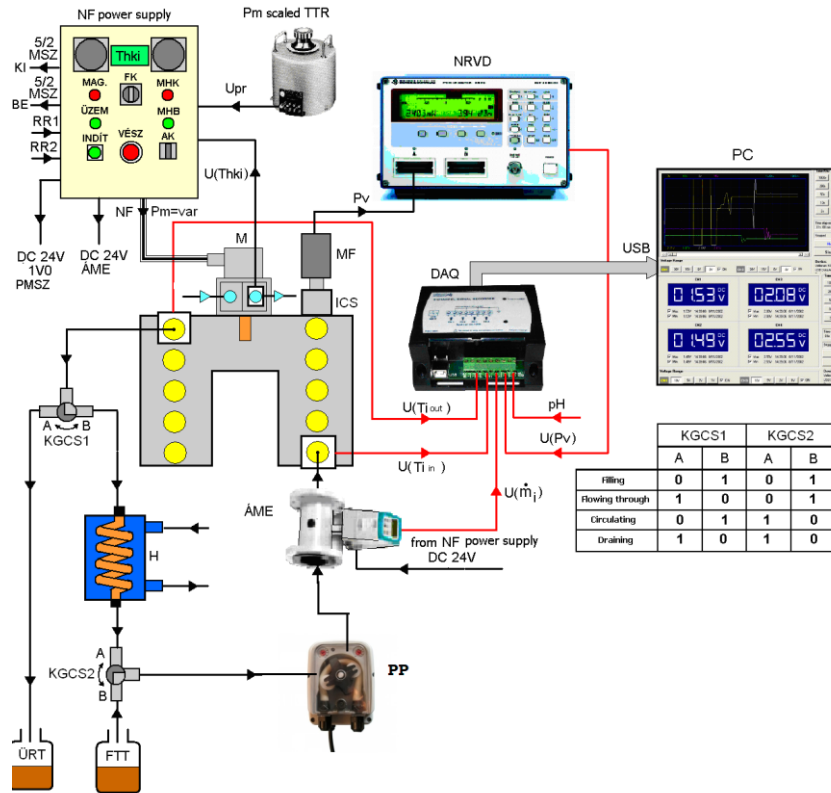


Figure 1. Microwave pre-treating system

A factorial experiment is an experimental strategy in which design variables are varied together, instead of one at a time. The lower and upper bounds of each of n design variables in the optimization problem needs to be defined. The allowable range is then discretized at different levels. If each of the variables is defined at only the lower and upper bounds (two levels), the experimental design is called 2^n full factorial. By careful design of experiments, the objective is to optimize a response (output variable) which is influenced by several independent variables (input variables). [4]

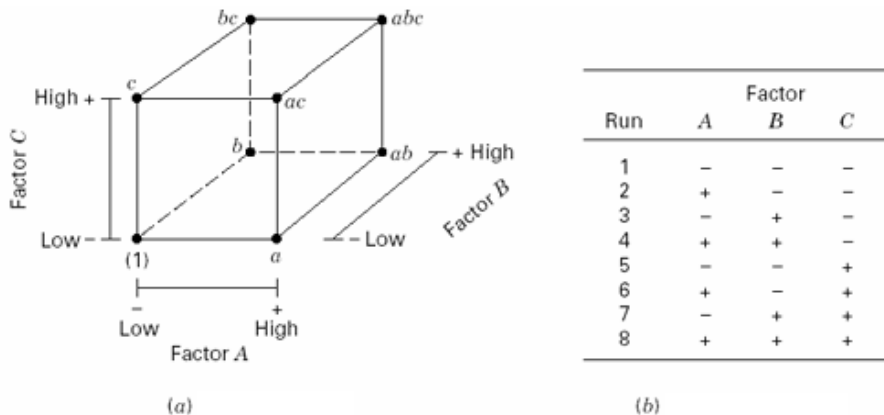


Figure 2: a) Geometric view of (2^3) factorial design b) design matrix of a 2^3 experiment [4]

Table 2: Factors and levels of operating parameters

Factors	Units	Low level (-1)	High level (+1)
(A) Power of the magnetron (PM)	W	300	700
(B) Flow rate (FR)	Lh ⁻¹	6	25
(C) Number of treatings (NT)	-	1	5

In some experiments, when the difference in response between the levels of one factor is not the same at all levels of the other factor, there is an interaction between the factors. The most important case of factorial design is the design for n factors, when the experiment is conducted at two levels for each factor, the high and low levels of a factor. In this case, a complete replicate of such a design requires (2^n) observations or 2^n factorial design. As shown in Fig 2, all treatment combinations can display geometrically as a cube. [11] The experiments were conducted to analyse the effect of power of the magnetron (PM), flow rate (FR), number of treating (NT) on the specific energy demand (SED). As a result (Table 2), each factor was set to the low (-1) and high (+1) levels. Two replications of each process conditions were conducted resulting in a total of 16 tests. Taking into consideration that over a certain value of irradiated microwave energy the degree of anaerobic decomposition was worsened, the PM and FR rate was set to achieve a range of 0.5-1.5Wg⁻¹. [9]

Regression algorithms are more robust, precise and show fewer round off and multicollinearity errors when variables are coded and centered, so PM, FR and NT values were codified according to expressions (3), (4) and (5), even though they could not be exactly centered

$$x_1 = \frac{PM - (PM_{high} + PM_{low}) / 2}{(PM_{high} - PM_{low}) / 2} \quad (3)$$

$$x_2 = \frac{FR - (FR_{high} + FR_{low}) / 2}{(FR_{high} - FR_{low}) / 2} \quad (4)$$

$$x_3 = \frac{NT - (NT_{high} + NT_{low}) / 2}{(NT_{high} - NT_{low}) / 2} \quad (5)$$

where x_1 is the coded factor that represents the power of the magnetron (PM), x_2 is the coded variable that represents the flow rate (FR) and x_3 is the coded variable that represents the number of treating (NT).

3. RESULTS AND DISCUSSION

The experimental plans were developed for establishing the quadric model of SED. These results were input into the Design Expert software. Therefore, the test for significance of the regression model, for significance on individual model coefficients and the test for lack-of-fit were performed to verify the goodness of fit of the obtained quadratic model. The analysis of variance (ANOVA) is usually applied to summarize the above tests performed. Without performing any transformation on the response, examination of the Fit Summary output revealed that the quadratic model is statistically significant for both responses and therefore it will be used for further analysis. The value of model "P > F" for the model is less than 0.05, which indicates that the term in the model have a significant effect on the response. The value of $P < 0.0001$ indicates that there is only a 0.01% chance that a "model F- value" this large could occur due to the noise. Values greater than 0.1000 indicate the model term is not significant.

Table 3: Analysis of variance (ANOVA) for SED

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	7.030E+006	6	1.172E+006	25.44	0.0002	significant
(A) Power of the magnetron (PM)	7.638E+005	1	7.638E+005	16.59	0.0047	
(B) Flow rate (FR)	2.056E+006	1	2.056E+006	44.65	0.0003	
(C) Number of treating (NT)	2.731E+006	1	2.731E+006	59.30	0.0001	
AB	2.556E+005	1	2.556E+005	5.55	0.0506	
AC	3.232E+005	1	3.232E+005	7.02	0.0330	
BC	9.005E+005	1	9.005E+005	19.55	0.0031	
Residual	3.224E+005	7	46053.82			
Pure Error	249.33	5	49.87			
Cor Total	7.353E+006	13				

The statistical significance of the fitted quadratic model for SED was evaluated by the F-test of the ANOVA, and shown in Table 3. When the values of the “Prob. > F” in the Tables 3 for the term of models are less than 0.05, indicates that the obtained models are considered to be statically significance, which is desirable, as it demonstrates that the terms in the model have a significant effect on the responses.

Table 4: Statistics regarding developed model for SED

Statistics	Value
Std. Dev.	214.60
Mean	784.86
Coefficient of variations	27.34
R-Squared	0.9562
Adj R-Squared	0.9186
Pred R-Squared	0.1173
Adeq Precision	19.388
PRESS	6.490E+006

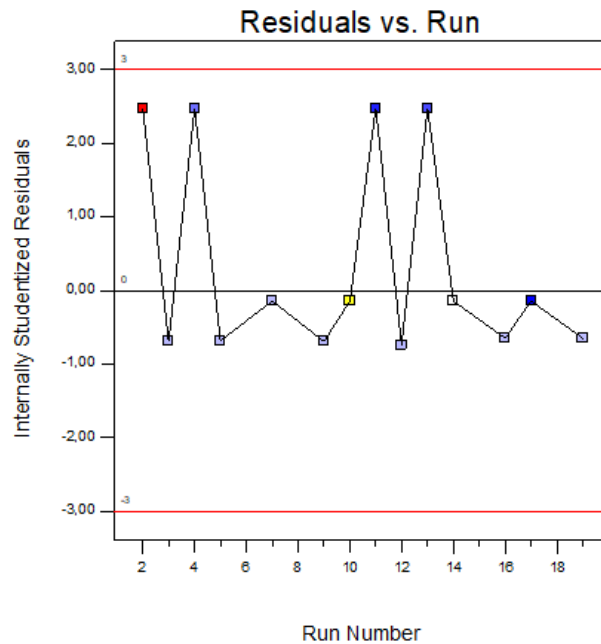


Figure 3: The comparison between measured and predicted value for SED

From Table 3 the Model F-value of 25,44 implies the model is significant. There is only a 0.01% chance that a “Model F-Value” this large could occur due to noise. Values of “Prob > F” less than 0.0500 indicate model terms are significant. In this case A, B, C, AC, BC are significant model terms. Values greater than 0.1000 indicate the model terms are not significant.

The “Pred R-Squared” of 0.1173 is in reasonable agreement with the “Adj R-Squared” of 0.9186. “Adeq Precision” measures the signal to noise ratio. A ratio greater than 4 is desirable. The ratio of 19.388 indicates an adequate signal. This model can be used to navigate the design space.

The regression model for SED in terms of actual factors is shown as follows:

$$SED = -833,26 + 1,5 \cdot PM + 46,64 \cdot FR + 314,57 \cdot NT - 0,094 \cdot PM \cdot FR + 0,5PM \cdot NT - 17,66 \cdot FR \cdot NT$$

The model obtained can be used to predict SED within the limits of the factors studied. The differences between measured and predicted responses are illustrated in Fig 3. The results of comparison were proved to predict values of SED close to those readings recorded experimentally with a 95% confident interval.

Fig 4-6 illustrate the contour plots of the interaction AB, BC and AC for SED respectively.

4. CONCLUSION

The purpose of this research is to quantify the effect of PM, FR and NT on SED. The factorial design was utilized to obtain the best operating condition which leads to the minimization of SED. ANOVA indicate that the (C) number of treating (NT) is the most significant factor followed by (B) flow rate (FR) and (A) power of magnetron (PM). Regarding the model validation, the regression model developed proves to be accuracy and has the capability to predict the value of response within the limits of factors investigated.

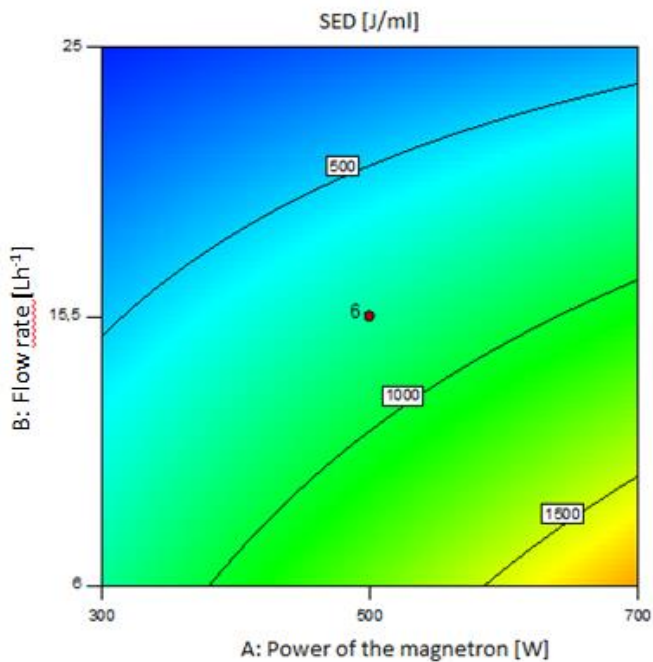


Figure 4: Contour plot of the interaction AB for SED

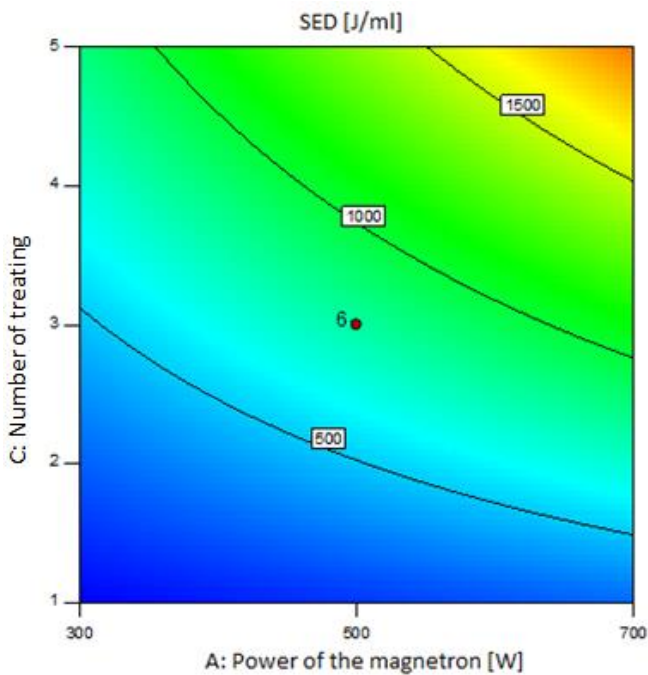


Figure 5: Contour plot of the interaction AC for SED

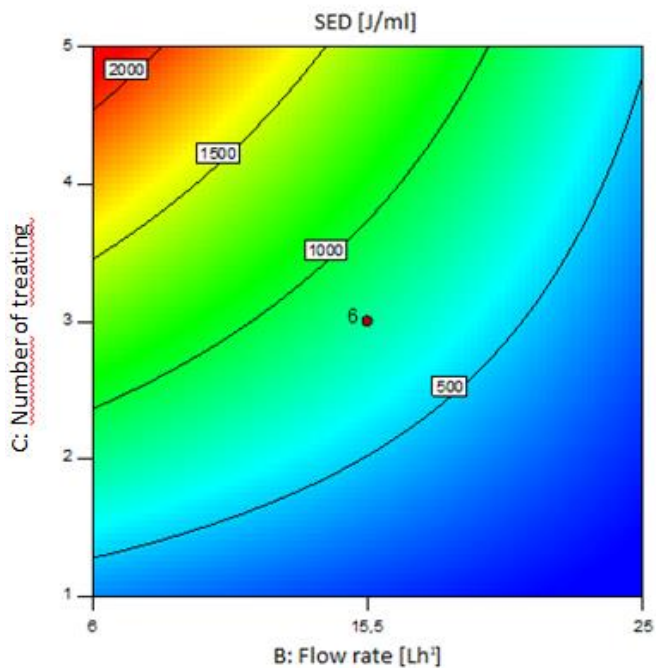


Figure 6: Contour plot of the interaction BC for SED

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