



## COMPARATIVE STUDY ON NATURAL PLANT ANTIBIOTICS – VEGETABLE AND THEIR CONSUMPTION AMONG COLLEGE STUDENTS

*Tünde Juríková, Ildikó Viczayová, Alžbeta Hegedúsová, Jiří Mlček,  
József Kontra, Lukáš Snopek, Marcel Golian*

### ABSTRACT

The research study is aimed at evaluation of natural plant antibiotics utilization among college students (554) with different subject study (Pre-school and elementary education, Biology, Regional Tourism, Horticulture, Physical education) from 3 countries – Slovak Republic, Czech Republic and Hungary. The attention has been focused on natural antibiotics in plants - vegetables (garlic, onion and horse radish) and the frequency of their consumption among college students. From the research results there is evident that majority of students had basic knowledge about natural plant antibiotics (85% of respondents) and they utilize them in everyday life (60.3%). The prevailing number of students utilizes synthetic antibiotics only rarely – once a year (33.4%) or never (37.5%). From achieved results about exact plants (garlic, onion and horse radish) consumption, the majority of respondents consume garlic once a week (42.2%); on the daily base the highest usage was noticed in the group of Slovak students with the subject of Physical education (32.1%) that could be considered as statistically different in comparison with the rest of groups. On the contrary, the lowest garlic consumption was noticed for students of biology (23.5%) and only small amount of students (3.6%) claimed that they have never included garlic into their diet. As for the onion, the majority of respondents (42.10%) also consume this commodity once a week; everyday consumption was noticed again especially between Slovak students with the subject of Physical education (32.1%) and Horticulture (31.1%). The results of these groups significantly differed from results of other groups. Third studied vegetable, horse-radish, it has never been consumed by Slovak students of Pre-school and elementary education in Slovak language (47.9%) that has been significantly distinguishable from another groups. Also Hungarian students of Physical education consume this commodity rarely (30.6%) – only once a year. Major part of students (46%) consumes horse-radish once a month. Czech students of Horticulture prefer consummation of horse-radish only once a month (76.8%). The lowest utilization was noticed in groups MU/ H (76.8%) consumed this commodity only monthly. Similarly, students of UP/ PE (30.6%) consumed horse radish only once a year that was significantly lower value in comparison with the rest of evaluated groups.

**Keywords:** natural plant antibiotics; garlic; onion; horse-radish; consumption; college students

### INTRODUCTION

The second half of the 20th century has brought the revival of traditional medicine as an alternative form of human health care. The worldwide increasing tendency of microbial resistance to classic antibiotics led researchers to investigate the potential antimicrobial activities of plants (vegetables, fruits, herbs and honey) (Cowan, 1999; Mahalingan et al., 2011; Nascimento et al., 2000; Valle et al., 2015; Kačániová et al., 2011; Fatrcová-Šramková et al., 2013).

Hundreds of plant extracts have showed antibacterial activity in vitro (Martin and Ernst, 2003) but this could not be translated into in vivo studies in humans in all cases. Thus results of antibacterial activity in plants could be in doubts. However, scientific research proved that plant

antibiotics might be reasonable natural alternatives for treating drug-resistance bacteria (Buhner, 2012). Moreover, herbal antibiotics could not only kill bacteria but also viruses and yeast and might strengthen the immune system (Juríková et al., 2016).

To the most known plants with natural antibiotics belong vegetables such as garlic, onion or horse-radish. Garlic and generally genus *Allium* has been labelled as leading plants for usage in the treatment of health problems with resistant microorganisms. Extracts and essential oils of these plants have shown wide antimicrobial activity (Jakubcova et al., 2014). The researches proved an antibacterial effect of garlic (*Allium sativum*), onion (*Allium cepa*), leek (*Allium porrum*), Chinese chives (*Allium tuberosum*) and chives (*Allium schoenoprasum*) against *G. +S. aureus*, *L.*

monocytogenes and G – *S. typhimurium* and *C. jejuni* and against oral pathogenic *Streptococcus mutans* and *S. sobrinus* (Kim, 1997; Elnima et al., 1993), but there is no effect against *Helicobacter pylori* infections (Ayidin et al., 1997; Graham et al., 2004; Mnayer et al., 2014).

Aqueous and hydroalcoholic extracts (40%) of garlic have been effective against *S. aureus* strain and isolated *Streptococcus oralis* and *S. mitis* (Silva and Fernandez, 2010). Study of Betoni et al. (2016) showed antibacterial activity of methanol extracts (70%) of garlic leaves against *S. aureus*.

The main antimicrobial agent in onion is quercetin and allicin (thio-2-propene-1-sulfinic acid-5-allyl-esters). Quercetin binds to the bacteria DNA gyrase while allicin inhibits certain thiol containing enzymes in the microorganisms by the rapid reaction of thiosulfinates (Park et al., 2008).

The antimicrobial activity of isothiocyanates extracted from horseradish root were investigated against oral microorganisms: 6 strains of facultative anaerobic bacteria, *S. mutans*, *S. sobrinus*, *L. casei*, *S. aureus*, *E. faecalis* and *Aggregatibacter actinomycetemcomitans*; yeast *C. albicans*, and 3 strains of anaerobic bacteria, *F. nucleatum*, *Prevotella nigrescens* and *C. perfringens*. Isothiocyanates isolated from horseradish root was effective against 4 strains of antibiotic-resistant bacteria, methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant *S. aureus* (VRSA), multidrug-resistant *Acinetobacter baumannii* (MRAB), and multidrug-resistant *P. aeruginosa* (MRPA), and 3 pathogenic bacteria, *S. aureus*, *A. baumannii*, and *P. aeruginosa* (Kim et al., 2015).

Our comparative research has dealt with an investigation of utilization of some vegetables with natural antibiotics, in contrary to synthetic antibiotics, in students' life. The consumption of the most common and widely utilized natural antibiotics in vegetables (garlic, onion and horseradish) has been evaluated in the group involving 554 college students. For this type of study the questionnaire method was chosen as the most relevant. Furthermore, the differences between field of study and university country have been taken into account too.

## MATERIAL AND METHODOLOGY

Research respond group involved 554 college students (337 women, 217 men) from 3 countries: Slovak Republic, Czech Republic and Hungary. Selected students of three Slovak universities (Constantine the Philosopher University, Slovak University of Agriculture, Comenius University), one Czech university (Mendel University in Brno) and one Hungarian university (University of Pécs) had wide range of study program fields – Pre-school and elementary education, Horticulture, Physical education (Sport Education), Biology, Regional Tourism. The exact sorting of students groups with numbers are given in Table 1.

Students were asked on consumption of natural and synthetic antibiotic generally. In the research our attention was then focused on the consumption of selected vegetables containing natural antibiotics (garlic, onion, and horseradish) with evaluation of their usage frequency.

The statistical evaluation was provided with the program STATISTICA 6.0 by a method of ANOVA and post-hoc tests Tamhane and Dunett T 3 on two levels of probability – 99% and 95%.

## RESULTS AND DISCUSSION

The evaluation of natural and synthetic antibiotics consumption among college students

First question of the questionnaire was aimed on the knowledge of college students about natural antibiotics and their utilization in their common life. The results of research are summarized in Figure 1 – 2.

The results showed that the majority of students had basic knowledge about natural antibiotics (85%) and utilize them in their life (60.3% of respondents) what could be mentioned as positive fact. Our results are in accordance with a research of Juríková et al. (2015) that mapped the consumption of natural antibiotics among college students in Slovakia (Nitra).

By contrast synthetic antibiotics use among college students has been noticed mainly once a year (33.4%) or never (37.5%). In the previously mentioned research of Juríková et al. (2015) there was shown higher number of

**Table 1** Overview of respondents – college students, according to university and their field of study.

University/Abbreviation	Field of study	Number of students	Group number
Constantine the Philosopher University CPU	PEES – Pre-school and elementary education in Slovak language	48	8
	PEEH – Pre-school and elementary education in Hungarian language	95	3
	BI – Biology	47	5
	RT – Regional Tourism	50	6
Mendel University in Brno MU	H – Horticulture	112	7
Slovak University of Agriculture SUA	H – Horticulture	45	1
University of Pécs UP	PE – Physical education	134	4
Comenius University CU	PE – Physical education	53	2

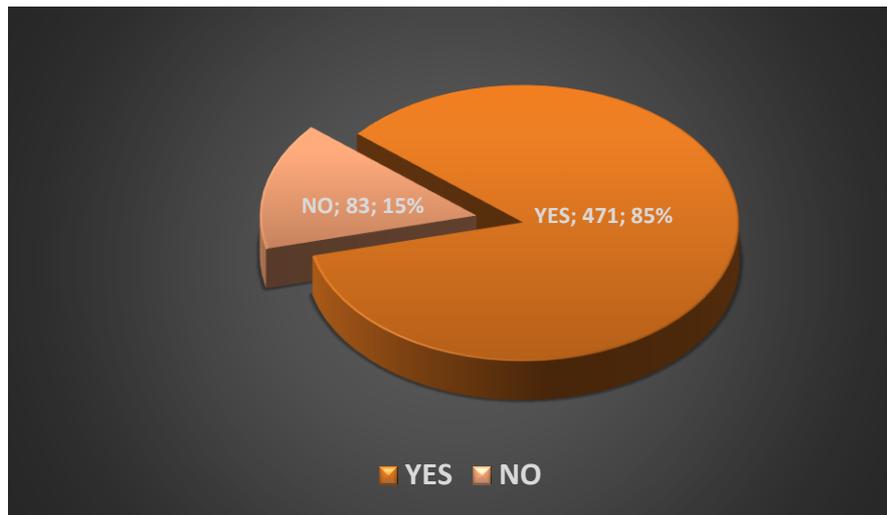


Figure 1 The evaluation of basic knowledge about natural antibiotics.

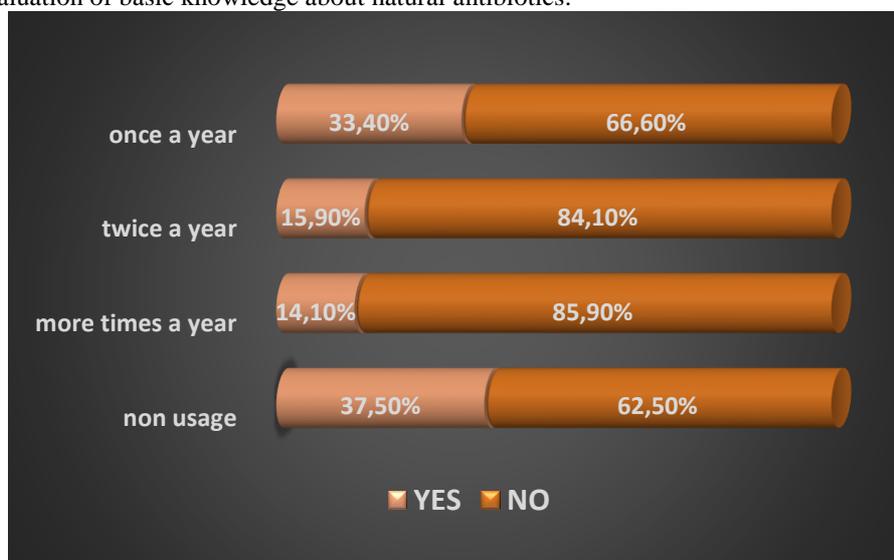


Figure 2 The frequency of utilization of synthetic antibiotics.

college students utilizing synthetic antibiotics, the most often it was several times a year.

### The evaluation of garlic consumption among college students

Garlic was consumed on everyday base by 32.1% college students of Comenius University with the field of study program PE as seen in Figure 3. This result can be considered as statistically significantly different in comparison with some other groups of students, CPU/PEEH 0 % ( $p < 0.001$ ), UP/PE 8.2% ( $p < 0.01$ ), CPU/BI 0% ( $p < 0.001$ ), CPU/RT 2% ( $p < 0.01$ ), MU/H 0% ( $p < 0.001$ ) and CPU/PEES 2.1% ( $p < 0.01$ ).

Statistically significant differences were proved also between the results for groups UP/PE 8.2% and CPU/PEEH 0% ( $p < 0.01$ ), CPU/BI 0% ( $p < 0.01$ ), MU/H 0% ( $p < 0.05$ ). The highest consumption of garlic once a week was noticed in the group MU/H 82.1%. This value statistically differed with SUA/H 20.0% ( $p < 0.001$ ), CU/PE 67.9% ( $p < 0.001$ ), CPU/PEEH 32.6% ( $p < 0.001$ ), UP/PE 61.9% ( $p < 0.001$ ), CPU/BI 17.6% ( $p < 0.001$ ), CPU/RT 38.0% ( $p < 0.001$ ), MU/H 82.1% ( $p < 0.001$ ) and CPU/PEES 31.3% ( $p < 0.001$ ).

As shown on Figure 5, garlic was consumed twice a week by respondents from the groups SUA/H 31.6%, CPU/PEEH

24.6%, UP/ PE and CPU/PEES 31.3%. College students from the group MU/H (9.8%) took statistically significantly less amount of garlic with the frequency twice a week than respondents from groups CPU/PEEH ( $p < 0.01$ ) and UP/PE ( $p < 0.05$ ).

The most evident statistically significant differences in monthly consumption of garlic (Figure 6) were proved between groups MU/H 3.6% and respondents from SUA/H 33.3% ( $p < 0.01$ ), 26.4% CU/PE ( $p < 0.01$ ), CPU/PEEH and UP/PE 28.4% ( $p < 0.01$ ), 47.1% CPU/BI ( $p < 0.05$ ), 36.0% CPU/RT ( $p < 0.01$ ) and 27.1% CPU/PEES ( $p < 0.05$ ). Our results are in accord with research study of Juríková et al. (2015) mapping the garlic consumption among college students in Nitra.

As we can see on the Figure 7, 23.5% asked students from the group CPU/BI consumed garlic only once a year. Otherwise, consumption once a year was lowest in the case of respondents from groups SU/AH 1.9%, CU/PE 2.1%, CPU/PEEH 3.7%, CU/PE 2%, CPU/RT 3.6% and MU/H 4.2% together with CPU/PEES. The low consumption of garlic in case of CPU/PEEH is in accord with the results of study Juríková et al. (2016) in which the mentioned group displayed the lowest consumption of vegetable – once a day.

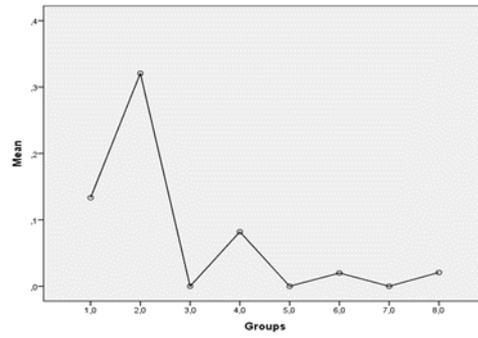


Figure 3 Consumption of garlic every day.

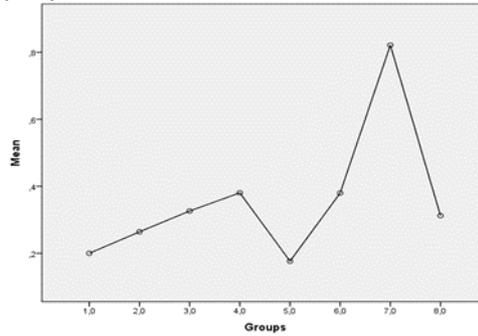


Figure 4 Consumption of garlic once a week.

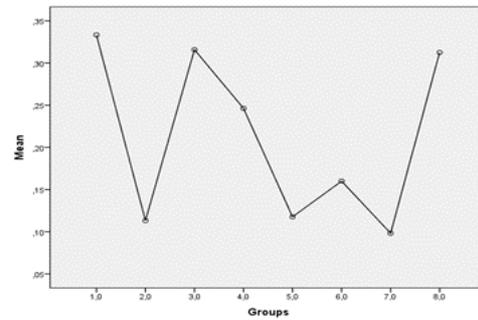


Figure 5 Consumption of garlic twice a week.

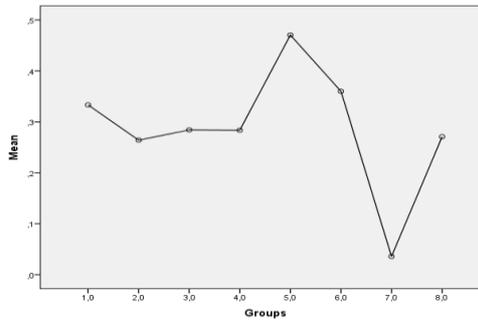


Figure 6 Consumption of garlic monthly.

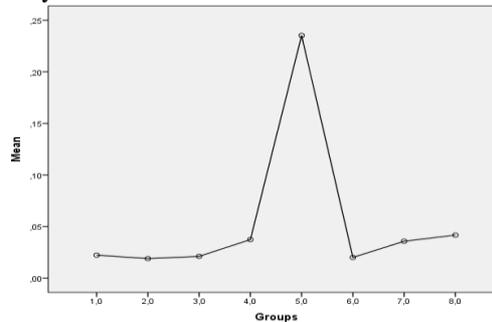


Figure 7 Consumption of garlic once a year.

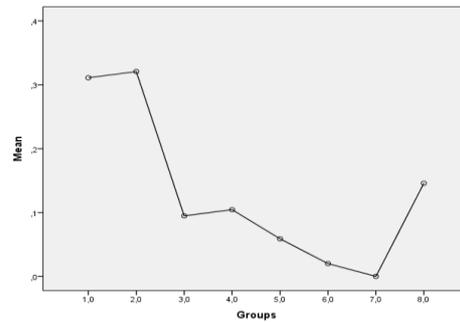


Figure 8 The everyday consumption of onion.

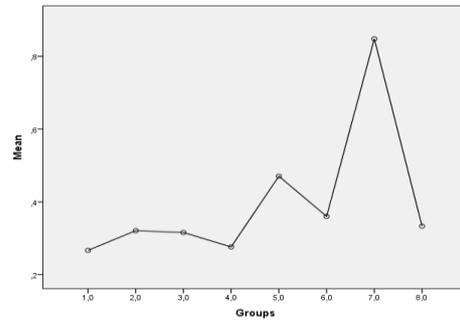


Figure 9 Consumption of onion once a week.

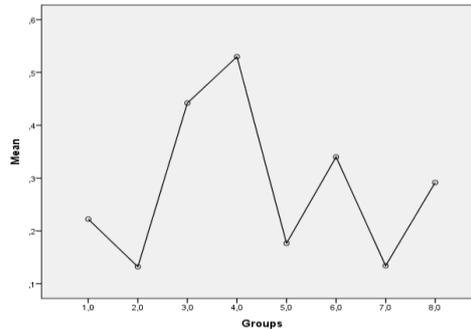


Figure 10 Consumption of garlic once a year.

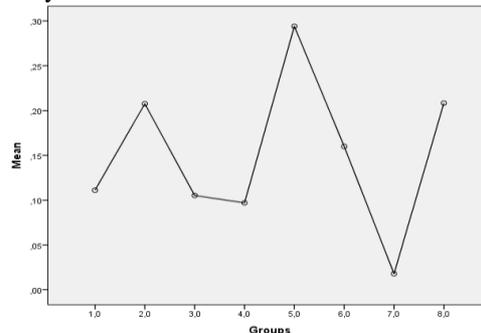


Figure 11 The everyday consumption of onion.

The differences between groups can not be considered as statistically significant. It is also interesting finding that students at secondary schools preferred to consume garlic only during illnesses (Juríková et al., 2016).

The lower consumption of garlic in fresh form can explained by taste disturbance and body odour after consumption as it has been mentioned by Graham et al. (1994).

The evaluation of onion consumption among college students

The highest consumption of onion on everyday base 32.1% was characteristic for the students of CU/PE and as well as SUA/H 31.1% (Figure 8). On the contrary, non

consumption of onion with frequency everyday was typical for respondents from groups MU/H, the difference between groups can be evaluated as statistically significant ( $p < 0.001$ ). Statistically significant difference was proved also between UP/PE 10.4% and MU/H 9.8% ( $p < 0.01$ ). On the basis of responses of students the highest consumption of onion was noticed in the consumption of onion once a week especially in the group of students MU/H 84.8%. The mentioned group statistically significantly differed from SUA/H 26.7% ( $p < 0.001$ ), CU/PE 32.1% ( $p < 0.001$ ), CPU/PEEH 31.6% ( $p < 0.001$ ), CPU/RT 36% ( $p < 0.001$ ) and CPU/PEES ( $p < 0.001$ ) (Figure 9). The relatively high everyday consumption of onion is on contrary with the study of Juríková et al. (2016) in which student groups of

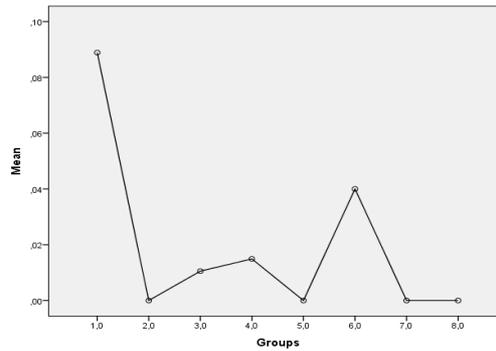


Figure 12 Consumption of onion once a week.

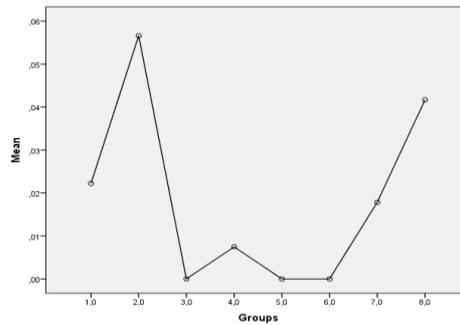


Figure 13 Everyday consumption of horse radish.

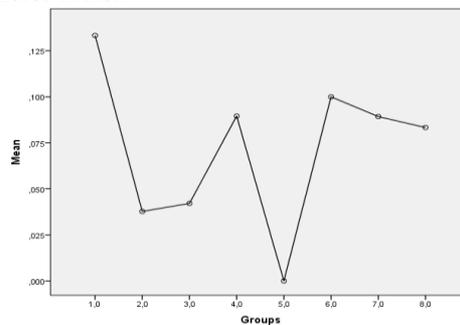


Figure 14 Consumption of horse radish once a week.

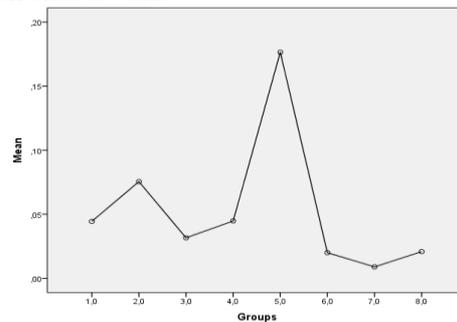


Figure 15 Consumption of horse radish twice a week.

CPU/PEEH and CPU/PEE S consumed the lowest amount of vegetable.

Twice a week consumed onion in the highest amount the respondents from the groups UP/PE 53% and CPU/PEEH 44.2%. On the contrary, the lowest consumption was typical for CU/PE 13.2%, CPU/BI 17.6% and MU/H 13.4%. Statistically significant differences were notified between the UP/PE and SUA/H ( $p < 0.01$ ), CU/PE ( $p < 0.001$ ), and MU/H ( $p < 0.001$ ) (Figure 10 – 11). Our results are in accord with results of Juríková et al. (2016) in which students at secondary schools preferred to consume onion 2 – 3 times a week.

Frequency consumption of monthly was noticed in the lowest frequency in MU/H 1.8% that significantly differed from CU/PE 20.8% ( $p < 0.05$ ). The highest value of consumption was noticed in CPU/BI 29.4% and CPU/PEES. Differences between the rest of groups can not be considered as statistically significant. Our results are corresponded with research of Juríková et al. (2015).

As we can see on Figure 12, the frequency of consumption of onion once a year represented the lowest values and the differences between groups were not be statistically significant ( $p > 0.05$ ).

### The evaluation of horse radish consumption among college students

Generally, everyday consumption of horse radish can be considered as a very low with the highest frequency CU/PE 5.7% and 4.2% CPU/PEES but the differences between groups can to be considered as statistically significant. The achieved results are in contrary with research study of **Juríková et al. (2016)** investigated more frequent consumption among college students in Nitra. On contrary, lower consumption of horse radish has been investigated among students from secondary school as it has been proved by another study of **Juríková et al. (2016)**. Horse radish consumed once a week no respondents from the group CPU/BI that statistically significantly differed from the groups UP/PE 9% ( $p < 0.05$ ) and MU/H 8.9% ( $p < 0.05$ ). All differences between the rest of groups can not be considered as statistically significant ( $p > 0.05$ ) (Figure 13 – 14).

The highest frequency of horse radish consumption twice a week was noticed in group of students CPU/BI 17.6%, the lowest in MU/H 0.9%. All differences between the assayed groups of students can not be evaluated as statistically significant ( $p > 0.05$ ). Monthly usage of horse radish was evaluated as the most frequent preference of students especially in groups MU/H 78.6%. Statistically significant differences between students was noticed between the MU/H and SUA/H 42.2% ( $p < 0.01$ ), CU/PE 39.6% ( $p < 0.001$ ), CPU/PEEH 42.1% ( $p < 0.001$ ), UP/PE 38.1% ( $p < 0.001$ ), CPU/RT 36% and CPU/PEES ( $p < 0.001$ ) (Figure 15 – 16).

As we can see, the highest percentage of horse radish consumption once a year was noticed in case of students CU/PE 30.6%. In group MU/H was the consumption of horse radish significantly lower in comparison with the groups CPU/PEEH 23.2% ( $p < 0.05$ ) and UP/PE 30.6% ( $p < 0.001$ ). The relatively high amount of consumed horse radish in group CPU/PEEH is on contrary with results of study **Juríková et al. (2016)**. The differences between another groups of students can not be noticed as statistically significant ( $p > 0.05$ ) (Figure 17).

### CONCLUSION

As a positive fact of our questionnaire (554 respondents) is the fact that the majority of college students (85%) had the basic knowledge about natural antibiotics and moreover they used them in everyday life (60.3%). The prevailing number of students utilize synthetic antibiotics only once a year (33.4%) or never (37.5%). The most common usage of natural antibiotics among students is the consumption of garlic once a week (42.2%); the highest consumption was noticed in the group of Slovak students with the main college subject of Physical education (32.1%). On the contrary, the lowest garlic utilization was noticed for students of biology (23.5%). Also onion is consumed by the majority of respondents (42.10%) once a week. Everyday consumption was noticed for students of CU/PE (32.1%) and SUA/H (31.1%) that significantly differed from other groups of students. The biggest group of students (46%) consume horse radish monthly. The lowest consumption was noticed in case of UP/PE student group (30.6%) that consume horse radish only once a year.

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### Contact address:

doc. RNDr. Tünde Juríková, PhD., Institute for Teacher Training, Faculty of Central European Studies, Constantine the Philosopher University in Nitra, Drážovská 4, 949 74 Nitra, Slovakia, E-mail: [tjurikova@ukf.sk](mailto:tjurikova@ukf.sk)

PaedDr. Ildikó Viczayová, PhD., Institute for Teacher Training, Faculty of Central European Studies, Constantine the Philosopher University in Nitra, Drážovská 4, 949 74 Nitra, Slovakia, E-mail: [iviczayova@ukf.sk](mailto:iviczayova@ukf.sk)

prof. RNDr. Alžbeta Hegedúsová, PhD., Slovak University of Agriculture in Nitra, Faculty of Horticulture and Landscape Engineering, Department of Vegetable Production, Tulipánová 1117/7, 949 76 Nitra, E-mail: [alzbeta.hegedusova@uniag.sk](mailto:alzbeta.hegedusova@uniag.sk)

doc. Ing. Jiří Mlček, Ph.D., Tomas Bata University in Zlín, Faculty of Technology, Department of Food Analysis and Chemistry, nám. T. G. Masaryka 5555, 760 01 Zlín, Czech Republic, E-mail: [mlcek@ft.utb.cz](mailto:mlcek@ft.utb.cz)

doc. József Kontra, PhD., University of Kaposvár, Faculty of Pedagogy, Department of Psychology, Új Tanügyi Épület 122, Hungary, E-mail: [kontra.jozsef@ke.hu](mailto:kontra.jozsef@ke.hu)

Ing. Lukáš Snopek, Tomas Bata University in Zlín, Faculty of Technology, Department of Food Analysis and Chemistry, nám. T. G. Masaryka 5555, 760 01 Zlín, Czech Republic, E-mail: [lsnopek@ft.utb.cz](mailto:lsnopek@ft.utb.cz)

Ing. Marcel Golian, Slovak University of Agriculture in Nitra, Faculty of Horticulture and Landscape Engineering, Department of Vegetable Production, Tulipánová 1117/7, 949 76 Nitra, E-mail: [marcel.golian1@gmail.com](mailto:marcel.golian1@gmail.com)