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THE COMPARATIVE STUDY OF MEDICINAL PLANTS UTILIZATION AS HERBAL ANTIBIOTICS BY COLLEGE STUDENTS

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ABSTRACT

The medicinal plant utilization has become more and more popular and increasing number of consumers prefer alternative medicine to synthetic antibiotic. Research dealing with evaluation of medicinal plant usage as herbal antibiotics including the sample of 584 quizzed college students aged 19 – 25 years (337 women, 217 men) originated from Slovak Republic (n = 338), Czech Republic (n = 112) and Hungary (n = 134). According to university and the study programme the following groups were evaluated: Constantine the Philosopher University **CPU** (**PEES** – Pre-school and elementary education in Slovak language, **PEEH** – Pre-school and elementary education in Hungarian language, **BI** – Biology, **RT** – Regional Tourism), Mendel University in Brno **MU** (**H** – Horticulture), Slovak University of Agriculture **SUA** (**H** – Horticulture), University of Pécs **UP** (**PE** – Physical education), Comenius University **CU** (**PE** – Physical education). The study was aimed at the evaluation of the significance of the country and the study programme for the use of the most commonly used herbs: plantain, elderberry, stinging nettle, ginger and coneflower (*Echinacea*). Our results showed that the choice of preferred medicinal plants as herbal antibiotics during illness had not been clearly influenced by country or field of study programme. Plantain was the most frequently used herb by students of UP/PE (51.5%), CPU/PEES and CPU/PEEH (47.9%; 41.1%). Elderberry was the most popular herb among the students CPU/BI (52.9%), CPU/RT and SUA/H (37.8%). Stinging nettle was preferred as the most popular herb in groups of CPU/RT (46%). The significantly lower consumption of *Echinacea* was noticed in MU/H 4.5% in comparison with groups, CU/PE 26.4% (p <0.05), CPU/PEEH 27.4% (p <0.01), UP/PE 17.2% (p <0.05) and CPU/RT 28% (p <0.05). Regularly, all the year round the highest utilization of *Echinacea* was evident in CPU/BI 30.0%. The highest percentage formed respondent's utilized *Echinacea* only during illness. Otherwise, the differences between the frequencies of *Echinacea* usage cannot be considered as statistically significant. Generally, a significantly higher level of ginger usage was assayed within groups SUA/H 80.0% (p <0.001), CPU/PEEH 66.3% (p <0.001), UP/PE 36.6% (p <0.001), CPU/BI 58.8% (p <0.001), CPU/RT 56.0% (p <0.001), MU/H 78.6% (p <0.001) and CPU/PEES 77.1% (p <0.001) in comparison with the rest of the groups. Daily the respondents from CU/PE 20.8% consumed ginger significantly more often than students belonging to CPU/BI 0.0% (p <0.05) and MU/H 0.0% (p <0.05). Respondents from CPU/PEEH consumed statistically significantly more ginger once a week in comparison with students belonged to MU/H 0.9% (p <0.05). To sum up the research results, we can claim that state or study programme had no clear statistically significant evidence on the regular consumption of medicinal plants as herbal antibiotics.

Keywords: herbal antibiotic; medicinal plant; college student; frequency of usage

INTRODUCTION

An increased number of multidrug resistance of pathogens forces us to look for natural sources as alternative therapy for treatment of infectious diseases. Due to the high effectiveness of essential oils, terpenoids, polyphenols and other biologically active substances isolated from medicinal plants against microbes the researches on antimicrobial activity of plants have been more and more actual **(Mbosso et al., 2010; Jakubcova et al., 2014; Juríková et al., 2016a; Juríková et al., 2017)**. Phytotherapy has a rich tradition in Slovakia including widely grown or cultivated herbs. Nowadays between 150 and 200 medicinal plants are actively used as a part of therapy **(Salamon, 1995; Salamon, 2014)**. The leading position among medicinal plants in Slovakia with antimicrobial effect has traditionally used herbs **(Candan et al., 2003; Modarresi-Chahardehi et al., 2012; Juríková et al., 2016b; Juríková et al., 2016c)**. For example, extract of broadleaf plantain (*Plantago major*) display high antibacterial properties against *Staphylococcus aureus* and *Bacillus cereus*, moderate against *Pseudomonas aeroginosa* and *Acinetobacter bowi*, narrow leaf plantain (*P. lanceolata*) teas demonstrate good antimicrobial activity *in vitro*, *in vivo* test showed

a significant decrease in growth of *Streptococcus* strains **(Betoni et al., 2006; Ferrazzano et al., 2015)**. Extract isolated from flowers of elderberry (*Sambucus nigra*) exhibited strong antimicrobial effects on various nosocomial pathogens notably upon methicillin-resistant *Staphylococcus aureus* MRSA **(Hearst et al., 2010)**. Stinging nettle (*Urtica dioica*) displayed the highest inhibition against some pathogenic bacteria such as *Bacillus cereus*, MRSA and *Vibrio parahaemolyticus* **(Saffidine, Sahli and Zerroug, 2015)**. The microbial spectrum of the *Echinacea* extracts was broad, with activity against all microbial type **(Juríková et al., 2016b; Juríková et al., 2016c)** especially against *Clostridium difficile*, *Streptococcus pyogenes*, *Haemophilus influenzae*, *Legionella pneumophila* and *Propionibacterium acnes* **(Sharma et al., 2008)**. Extract isolated from coneflower (*Echinacea purpurea*) showed also a significant growth inhibition of *Candida albicans* **(Stanisavljevič et al., 2009)**. Except for traditionally used medicine in Slovakia it has become more and more popular to consume of ginger **(Juríková et al., 2016c)**. It is common for ginger (*Zingiber officinale*) to be used in the treatment of flu and colds. Moreover, the plant is known for soothing and antibacterial properties too **(Hara et al., 1998; Park, Bae and Lee, 2008; Costa et al., 2009)** especially against *S. aureus*, *S. pyogenes* and *P. aeruginosa* and also *Helicobacter pylori*. This strong antibacterial activity authors explain by the content of resins and volatile oils such as borneol, camphene, citral, eucalyptol, linalool, phellandrene, zingiberine and zingiberol phenols **(Ahmad et al., 2008; Rosato et al., 2007)**. Ginger (*Zingiber officinale*) possess effective anti-bacterial activity against multi-drug resistant clinical pathogens causing nosocomial infection **(Ponmurugan and Shyamkumar, 2012)**, especially against drug resistant *Escherichia coli* **(Rahman et al., 2011; Ushimaru et al., 2012)**, *Bacillus subtilis* **(Alzoreky and Nakahara 2003)**, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Shigella sonnei*, *Staphylococcus epidermidis* and *Salmonella typhi* **(Betoni et al., 2006; Gull et al., 2012)**.

Due to the fact that during the last two decades there has been evident return towards the alternative sources of medicine, our research has been dealing with the mapping of traditionally used (elderberry, stinging nettle) and historically important (ginger, *Echinacea*) medicinal plants displayed antibacterial effect **(Sikkema, de Bont and Poolman, 1994)**. Furthermore, it has been statistically evaluated that the differences between three countries and research focused on the evaluation of study programme the importance in relation to usage of medicinal plants displayed antibacterial effect. The results represented in the second part of research and continue the evaluation of herbal antibiotic – vegetable among college students.

Scientific hypothesis

H1

We suppose that there have been statistically significant differences in consumption of herbs as natural antibiotics among assayed countries.

H2

We suppose that there have been differences in consumption of evaluated herbs as natural antibiotics among college students with different field of study.

MATERIAL AND METHODOLOGY

The data were obtained by questionnaire method. Cross-sectional study was conducted among 584 college students aged 19 – 25 years (337 women, 217 men) from 3 countries: Slovak Republic, Czech Republic and Hungary. The overview of evaluated universities, field of studies and group number, number of students together with abbrevations is given in Table 1. College students were asked for consumption of medicinal plants generally – plantain (*Plantago*) sp., elderberry (*Sambucus nigra*), stinging nettle (*Urtica dioica*), ginger (*Zingiber officinale*) and coneflower (*Echinaceae sp.*) with mapping the frequency of usage in case of *Echinacea* and ginger.

Statistic analysis

The statistical evaluation was provided on programme STATISTICA 6.0 by method of ANOVA and post-hoc tests Tamhane and Dunett T 3 on the level of probability 99 and 95%.

RESULTS AND DISCUSSION

In the first part of study we focused our attention on mapping of usage of traditionally utilized herbs for the treatment of common respiratory diseases.

Comparison of the utilization of traditionally used herbs

The traditional used herbs involved are represented by elderberry, stinging nettle, plantain (narrowleaf and broadleaf) and coneflower – *Echinacea*.

The college students generally preferred to use plantain (34.7%) followed by elderberry (26.7%) and stinging nettle (25.3%) (Figure 1). Our results are similar to study of **Juríková et al. (2015)** mapping the consumption of the same medicinal plant sources with antimicrobial effect among the college students of Constantine the Philosopher University in Nitra. On contrary, the usage of coneflower (*Echinacea*) was the lowest (19.7%). It can be caused by the controversial studies pointed on the health benefits against microorganism only in prevention **(Juríková et al., 2016c)**.

The second part of research focused attention on mapping the usage of the most popular concrete herbs displaying antimicrobial activity in relation to country and study programme of students. The results of statistical evaluation showed that plantain was in the lowest amount utilized by study group CPU/BI 5.9% and CU/PE 13.2% (Figure 2). On the contrary, the highest one was noticed in respondents belonged to UP/PE 51.5% and CPU/PEES 47.9%. In comparison with the CPU/BI and CU/PE the statistically higher consumption was evident in group CPU/PEEH 41.1% (p <0.001), UP/PE 51.5% (p <0.001) and CPU/PEES 47.9% (p <0.001). There were proved statistically significant differences between UP/PE, CPU/RT 18% (p <0.001) and MU/H 28.6% (p <0.001). The hypotheses 1 and 2 have been proved.

Elderberry was used in significantly lower amount among quizzed college students of MU/H 2.7% than in groups of students belonging to the study programme SUA/H 38% (p <0.001), CPU/PEEH 27.4% (p <0.001), UP/PE 35.8% (p <0.001), CPU/BI 52.9% (p <0.001), CPU/RT 40% (p <0.001) and CPU/PEES 33.3% (p <0.001). It means that statistical hypotheses have been confirmed partially. In accordance with our results **Juríková et al. (2015)** found out the highest percentage of college students from Constantine Philosopher University (42.33%) preferred elderberry for treatment of respiratory illnesses. **Balla et al. (2013)** studied the utilization of the most frequent medicinal plants among 550 pupils from the Nitra region. They found out that the stinging nettle was the second most frequently used herb in case of respiratory diseases otherwise the **elderberry** belonged to non-popular medicinal plant.

It is interesting that no usage of stinging nettle was noticed in group of respondents belonged to MU/H. Statistically significantly higher amount of this herb was evident in groups CPU/PEEH 23.2% (p <0.001), CPU/PEES 39.6% (p <0.001) and UP/PE 40.3% (p <0,001). Statistically lower amount of stinging nettle was used within CU/PE 15.1% in comparison with college students belonged to UP/PE 40.3% (p <0.001) and CPU/RT 46% (p <0.05). It means that statistically significant differences have been confirmed among different field of studies and **countries** as well.

Coneflower (*Echinacea*) (Figure 5) was consumed in significantly lower amount within MU/H than in groups SUA/H 33.3% (p <0.001), CPU/RT 28.0% (p <0.05), CPU/PEEH 27.4% (p <0.001), CU/PE 26.4% (p <0.05) and UP/PE 17.2% (p <0.05). So hypotheses 1 and 2 were confirmed partially. On contrary, in previous study of **Juríková et al. (2015)** mapping the consumption of herbal antibiotics among college students in Nitra pointed to the highest percentage of respondents with non utilisation of the mentioned herb.

As we can see in Figure 6, only in winter time was *Echinacea* used in the highest amount within SUA/H (17.8%), in the lowest in CPU/PEES (2.1%) and MU/H (2.7%). Regularly, all the year round, the highest utilisation of echinacea was evident only in group CPU/BI 11.8% (Figure 7). On the contrary, non consumption all year was noticed in MU/H. The differences among evaluated groups can not be considered as statistically significant ($p \geq 0.05$). So hypotheses 1 and 2 have not been confirmed. Students of CPU/BI, CPU/PEEH consumed higher amount of *Echinacea* all year in comparison with CU/PE, UP/PE, CPU/RT, MU/H and finally CPU/PEES. So the differencies between selected groups have not represented the clear evidence the influence of field of study of students and **countries** as well.

The highest percentage of respondents claimed that they utilized *Echinacea* only during illness, except for respondents belonged to group UP/PE 17.2% (Figure 8) with no significant differences among groups and **countries**. Similarly, **Juríková et al. (2015)** mapping the frequency of *Echinacea* utilization among college students from Nitra (CPU and SUA) found out the highest percentage of college students utilized this herb only during illness. On the contrary, the majority of students at secondary schools stated that they did not like this herb and have never utilized it in common life (boys 56.06%; girls 65.71%) **(Juríková et al., 2016c)**. The decreasing popularity and tendency of using is given by controversial studies. They pointed to the fact that *Echinacea* could not prevent illness or reduce the length of symptoms **(Keith et al., 2003)**.

Significantly lower usage of ginger was noticed in UP/PE 36.6% in comparison with groups SUA/H 80.0% (p <0.001), MU/H 78.6% (p <0.001), CPU/PEES 77.1% (p <0.001) and CPU/PEEH 66.3% (p <0.001) (Figure 9).

In the same way the consumption of ginger twice a week can be evaluated as very low (Figure 12). Significantly higher level of consumption was registrated in group MU/H 14.3% in comparison with groups CU/PE 1.9% (p <0.05).

Daily the respondents from CU/PE 20.8% consumed ginger significantly more often than students belonging to CPU/BI and MU/H 0.0% (p <0.05). The differences between the rest of the groups cannot be considered as statistically significant ($p \geq 0.05$) (Figure 10). The hypotheses 1 and 2 have been confirmed only partially.

Respondents from CPU/PEEH consumed statistically significantly more ginger once a week in comparison with students of MU/H 0.9% (p <0.05). The highest usage with frequency once a week was evident in SUA/H 17.8% (Figure 11).

According to Figure 13 the highest percentage of college students preferred the monthly usage of ginger among another forms of usage. Our results are corresponded with the results of research study **Juríková et al. (2015)** in which college students from Nitra preferred to use ginger monthly (38% of quizzed students). It is evident that statistically a significantly lower consumption was noticed in groups UP/PE 27.6%, than in group MU/H 50% (p <0.001). Our results of research are more positive in comparison with **Juríková et al. (2016c)** evaluated the utilization of herbal antibiotics among students of secondary school. They found out that they used ginger only during the illness (16.66% – girls) or rarely (39.39% – boys). Our results are in conflict with another research study of **Sloand and Vessey (2001)**. According to study the majority of the adolescents (89%) have access to the medicine in their households, and most popular and frequent was ginger usage.

Once a year used the ginger 35.7% quizzed from groups MU/H that can be considered as significantly higher amount in comparison with respondents of CU/PE 5.7% (p <0.001), CPU/PEEH 9.5% (p <0.001) and UP/PE 21.6% (p <0.05) (Figure 14).

Explanation of groups for Figures 2 – 14: Group **1** – Slovak University of Agriculture **SUA** (**H** – Horticulture), **2** – Comenius University **CU** (**PE** – Physical education), **3** – Constantine the Philosopher University – **CPU** (**PEEH** – Pre-school and elementary education in Hungarian language, **BI** – Biology, **RT** – Regional Tourism), **4** – University of Pécs **UP** (**PE** – Physical education), **5** and **6** – Constantine the Philosopher University – **CPU** (**PEEH** – Pre-school and elementary education in Hungarian language) **BI** – Biology and **RT** – Regional Tourism, **7** – Mendel University in Brno **MU** (**H** – Horticulture), **8** – Constantine the Philosopher University – CPU (PEES – Pre-school and elementary education in Slovak language. Mean values (+/- 95% CI).

Table 1 Overview of college students according to university, field of study and number of students (with group designation and number in figures).

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

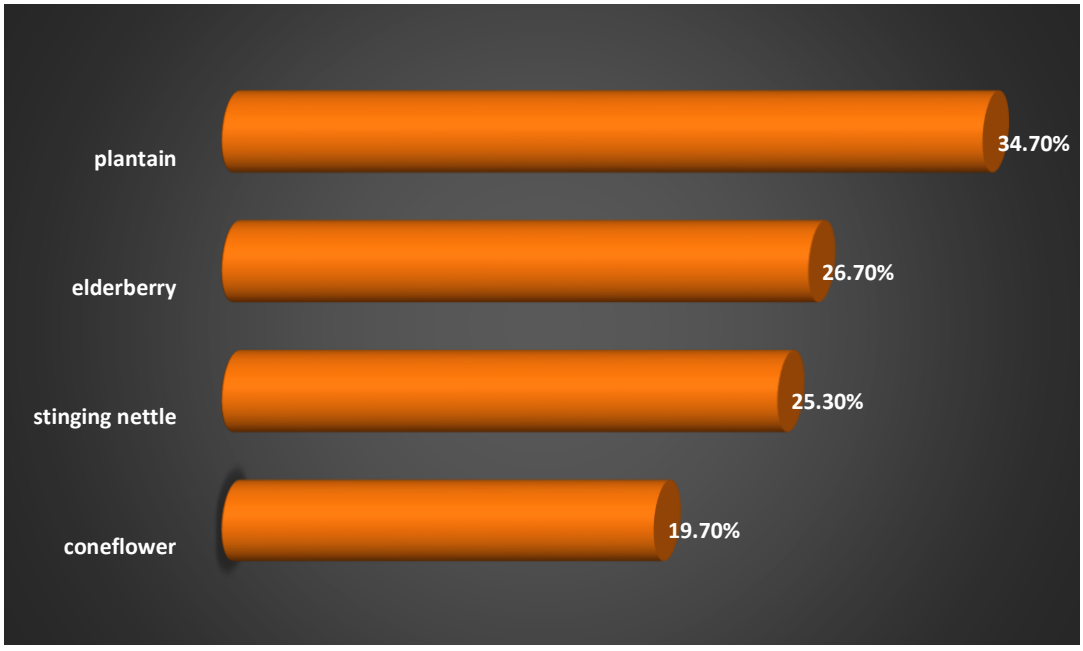

Figure 1 The comparison of traditionally utilized medicine plants with antibiotic effect.

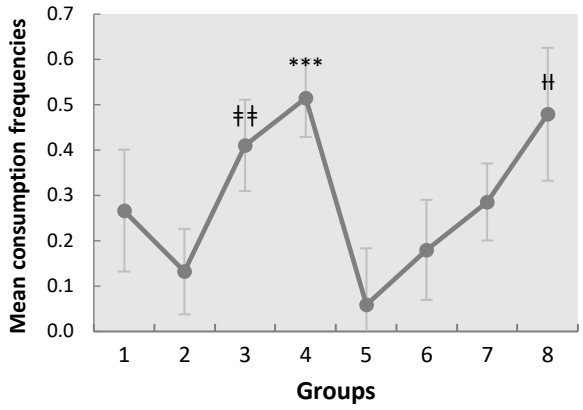

Figure 2 Consumption of plantain.
Note: *** p <0.001 group 4 vs. groups 5,6,7; ‡‡ p <0.01 group 3 vs. groups 2, 5; ‡‡ p <0.01 group 8 vs. groups 2, 5.

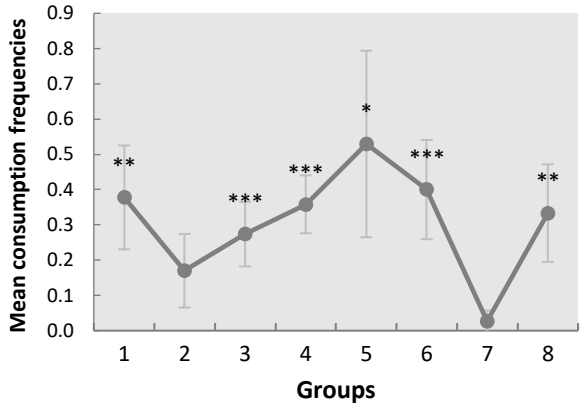

Figure 3 Consumption of elderberry.
Note: *** p <0.001 group 7 vs. groups 3,4,6; ** p <0.01 group 7 vs. groups 1, 8; * p <0.05 group 7 vs. group 5.

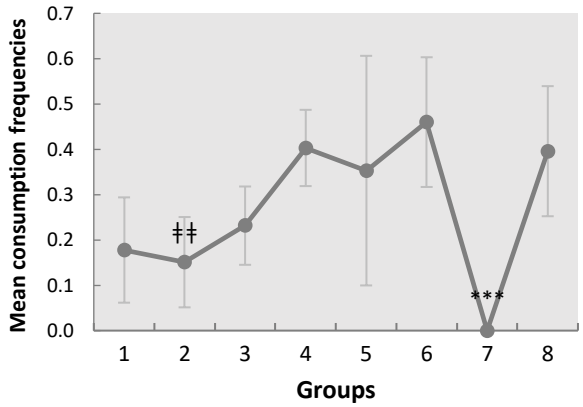

Figure 4 Consumption of stinging nettle.
Note: *** p <0.001 group 7 vs. groups 3, 4, 6, 8; ‡‡ p < 0.01 group 2 vs. group 4; ‡ p <0.05 group 2 vs. group 6.

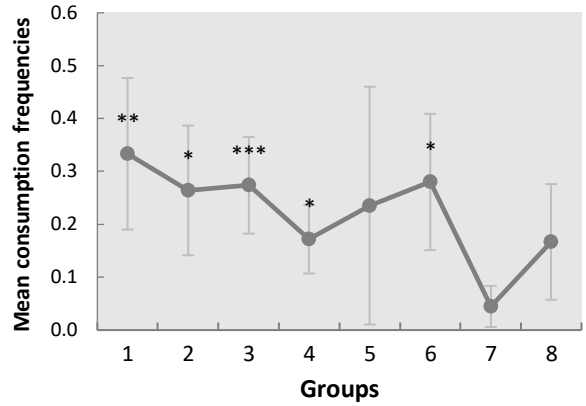

Figure 5 Consumption of coneflower (*Echinacea*).
Note: *** p <0.001 group 7 vs. groups 3; ** p <0.01 group 7 vs. group 1; * p <0.05 group 7 vs. groups 2, 4, 6.

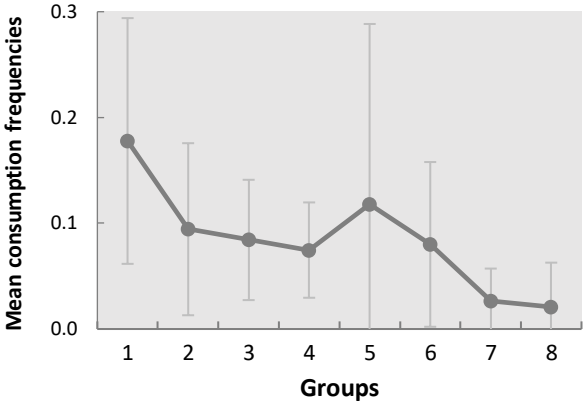

Figure 6 Consumption of *Echinacea* during winter time.
Note: $p \geq 0.05$.

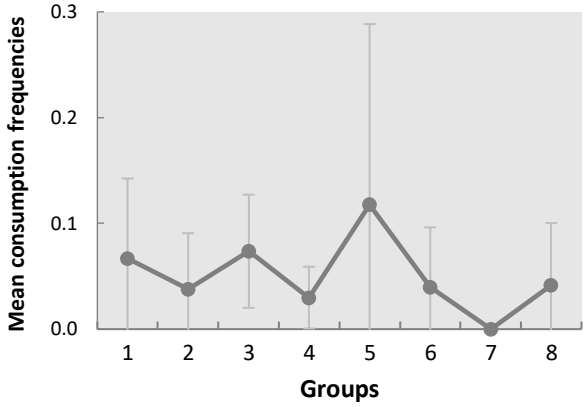

Figure 7 Consumption of *Echinacea* all year.
Note: $p \geq 0.05$.

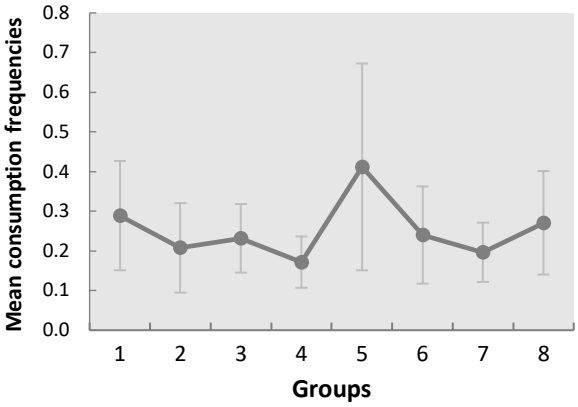

Figure 8 Consumption of *Echinacea* during illness.
Note: $p \geq 0.05$.

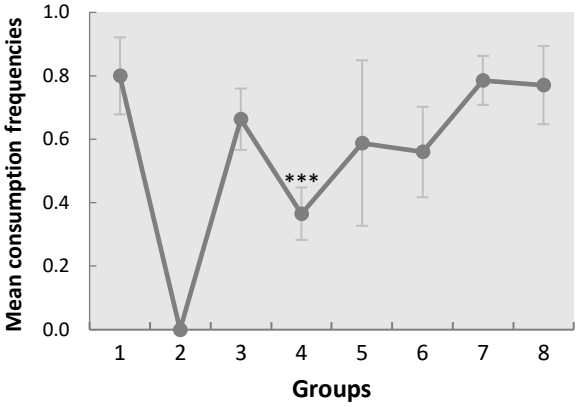

Figure 9 Consumption of ginger.
Note: *** $p < 0.001$ group 4 vs. groups 1, 3, 7, 8.

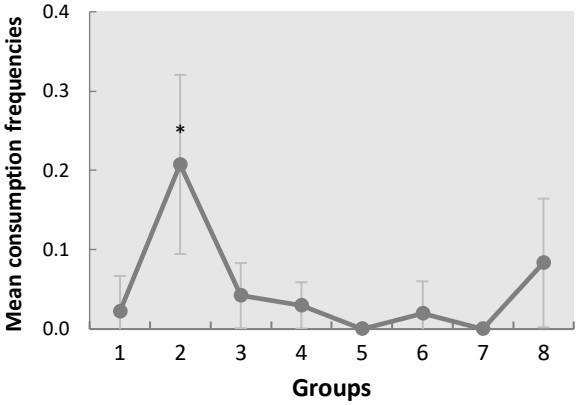

Figure 10 Daily consumption of ginger.
Note: * $p < 0.05$ group 2 vs. groups 5, 7.

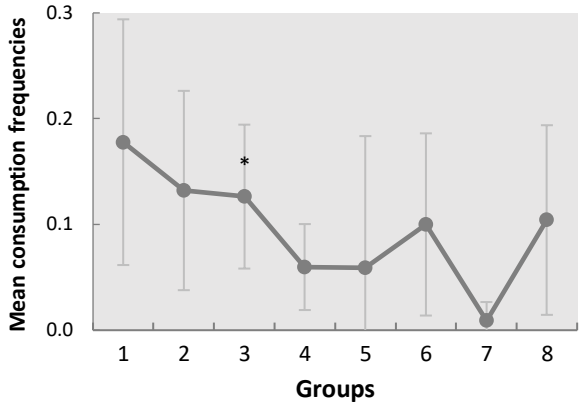

Figure 11 Consumption of ginger once a week.
Note: * $p < 0.05$ group 3 vs. group 7.

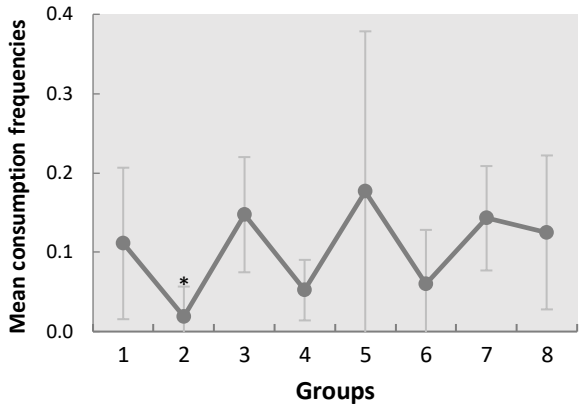

Figure 12 Consumption of ginger twice a week.
Note: * $p < 0.05$ group 2 vs. group 7.

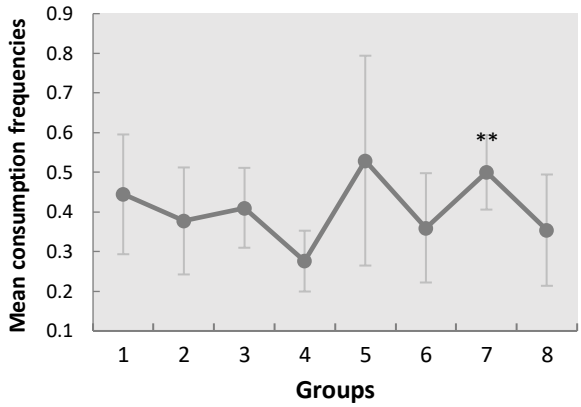

Figure 13 Consumption of ginger monthly.
Note: ** $p < 0.01$ group 7 vs. group 4.

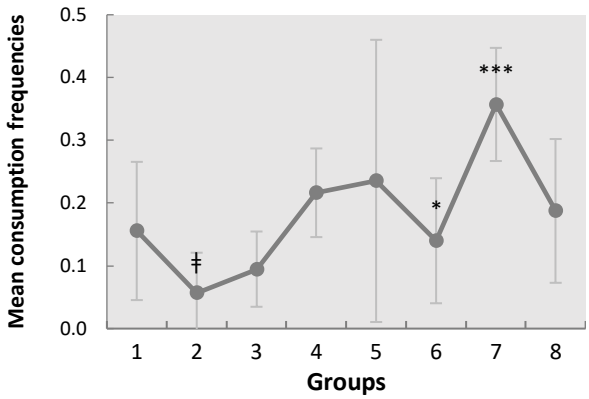

Figure 14 Consumption of ginger once a year.
Note: *** p <0.001 group 7 vs. groups 2, 3; * p <0.05 group 7 vs. group 6; ǂ p <0.05 group 2 vs. group 4.

CONCLUSION

To sum up the research results the assayed species of medicinal plants had different frequency of usage among college students in relation to countries and field of study. Plantain was preferred by students UP/PE (51.5%), CPU/PEES and CPU/PPEH (47.9% and 41.1%), elderberry by quizzed of CPU/BI (52.9%), CPU/RT (40%) and SUA/H (37.8%). Stinging nettle was popular among students of CPU/RT (46%) and as well as UP/PE (40.3%). *Echinacea* was used in preference of SUA/H (33.3%) and CPU/RT (28%). Despite the differences in usage of *Echinacea* they have not be statistically significant differences between assayed groups of students. On contrary, within the group UP/PE we noticed 80.6% usage of ginger that can be considered as significantly lower amount in comparison with the rest of the evaluated groups. The highest frequency of daily ginger utilization was noticed in group of students CU/PE, non usage was registered in groups MU/H a CPU/BI. The mentioned groups of students significantly differed from the rest of the evaluated groups. To sum up all assayed species, we can claim that country or study programme had no clear statistically significant evidence on the regular consumption of medicinal plants as herbal antibiotics. According to our opinion, the public popularity, preference in household, in the family have the greatest influence on usage biologically active substances isolated from medicinal plants.

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