ORIGINAL ARTICLE

CONTENTS

Using herbal remedies in shelter

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ABSTRACT

Aim: The selection and experimental verification of plants that have antibacterial, soothing, and iodine-enriching activity to form the phyto-aid kit in the shelter conditions.

Materials and Methods: Antibacterial activity was studied using the disco-diffusion methods. The iodine strip method was used for iodine deficiency research. To study the anxiolytic effect of plants, the Spielberger-Khanin method was used. Statistical analysis was performed using JASP software.

Results: Among the iodine-containing plants, *Xanthium strumarium* and *Potentilla alba* showed the greatest antibacterial activity. Studies of juices and fruits of fruit plants revealed the strongest antibacterial effect from the fruits of *Schisandra chinensis*. When comparing the iodine-enriching function of the group of iodine-containing plants, all the studied plants showed iodine-enriching activity, with a slight priority from *Zostera marina* and *Lemna minor.* Anxiolytic activity in the conditions of a shelter was also demonstrated by all the studied plants in the following decreasing order, namely *Valeriana officinalis, Crataegus ucrainica.*

Conclusions: The use of the studied plants in a shelter phyto-aid kit contributes to a more comfortable and safe stay for people in the shelter.

KEY WORDS: shelter, phyto-aid kit, antibacterial, iodine-enriching and calming plants

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INTRODUCTION

The war on the territory of Ukraine raised a number of urgent questions related to the problems of population civil protection. One of the aspects of civil defence is the functioning of shelters. According to Ryabova S.S. et all [1], most of the existing shelters cannot protect people from weapons of mass destruction and they are characterized by the inability to preserve the mental state of people during a long stay in a shelter. In the work of Kennetha L. et al [2], a thorough analysis of materials describing the effectiveness of the use of bomb shelters during World War II was made, the author proves that the use of bomb shelters saves lives.

Recently, works have appeared that describe the correct parameters of the physical environment that must be maintained in shelters, including temperature and humidity [3]. However, there are no works that describe the contents of aid kit in the shelter.

Historically, shelters had aid kits that contained antibacterial, sedative, iodine-enriching, and anti-radiation agents. In our opinion, searching for optimal plant components with similar effects to create the aid kit can contribute to a more comfortable and safer stay for people in a shelter, especially during long-term stays in the shelter.

Fatigue causes a person to need rest, which can be realized through relaxation and use of plants with a calming effect. Nervous and mental overstrain can lead to immunodeficiency, and immunomodulatory plants are able to restore the functions of immunocompetent organs. The monotonous interior of the shelter requires a change of impressions, which can be created with the help of herbal smells and teas.

AIM

The main aim of this research is the selection and experimental verification of plants that have antibacterial, soothing, and iodine-enriching activity to form the phyto-aid kit in the shelter conditions.

Table 1. Results of determination of antibacterial activity of iodine-containing plants

Test microorganisms	Zone of inhibition (mm)				
	Type of plant material				
	Zostera marina	***Potentilla alba***	***Xanthium strumarium***	***Laminaria saccharina***	***Lemna minor***
Escherichia coli	11,1±0,4	19,3±0,1*	29,8±0,3*	7,2±0,4	12,2±0,3*
Staphylococcus aureus	12,2±0,5*	18,4±0,5*	20,1±0,3*	7,2±0,6	9,6±0,7
Proteus vulgaris	11,1±0,4*	13,3±0,4*	11,1±0,2*	-	8,8±0,4
Pseudomonas aeruginosa	14,4±0,2*	14,2±0,9*	13,4±0,5*	11,1±0,3*	10,8±0,6*
Candida albicans	-	8,7±0,2*	8,1±0,3	7,2±0,8	11,1±0,7

Mean values±standard deviation of five independent experiments (n=25). *p≤0.05 compared with control (water), significantly by Student's Test

RESEARCH HYPOTHESIS

Plant raw materials with antibacterial, iodine-enriching, and soothing effects can be a preventive measure against iodine deficiency, stress, and bacterial diseases.

MATERIALS AND METHODS

OBJECT

Plants with antibacterial activity (*Schisandra chinensis* (Turcz.) Baill., *Viburnum opulus* L., *Vaccinium myrtillus* L.), plants with sedative effect (*Valeriana officinalis* L., *Borago officinalis* L., *Crataegus ucrainica* Pojark.), plants with iodine-enriching activity (*Laminaria saccharina* L., *Lemna minor* L., *Xanthium stumarium* L., *Potentilla alba* L., *Zostera marina* L.).

Antibacterial activity was studied by the method of paper discs (disco-diffusion). In Petri dishes, the culture under study was sown with a continuous lawn on the medium. Using sterile tweezers, paper disks (4-5 pieces) were placed on the nutrient medium with culture, which were moistened with a solution of the liquid under study. The sizes of the zones of bacterial growth inhibition determine the degree of sensitivity of the microorganism to the solution under study [4].

All microorganisms were obtained from the Ukrainian Microorganisms collection of the Institute of Microbiology and Virology named after D. K. Zabolotny of the National Academy of Sciences of Ukraine.

The Spielberger-Khanin questionnaire was used to study the sedative potential of plant materials. The method is considered valid because it can be used to determine two types of anxiety (situational and personal). Anxiety was measured by points, according to the gradation of points: up to 30 points – low; 31 – 44 points – moderate; from 45 high [5]. The control group received placebo in the form of 150 ml of boiled tap water.

Considering the psychosomatic connections, in parallel with the measurement of anxiety, we measured the pulse using a pulse oximeter. To determine the iodine-enriching activity, a group of volunteers consumed teas from the studied plants under the control of an iodine test. About 60 students of Dragomanov Ukrainian State University, who were in the same conditions, took part in the experiment.

Each experimental group conducted a preliminary test to detect iodine deficiency, then consumed tea from a certain plant for 15 days, after which the test was repeated. A similar experiment was conducted with respect to the control group.

Iodine deficiency was investigated by applying Lugol's solution to the skin of the forearm [6]. Teas from the studied plants were prepared according to the recommendations [7].

The statistical analysis was performed using JASP software.

The studies were conducted with informed consent from students and in compliance with the rules approved by the Ethics Committee.

RESULTS

As a result of the study, the antibacterial activity of various groups of medicinal plants was screened, both by purpose and by chemical composition. The results of the study are presented in tables 1, 2.

A comparison of the effect of the aqueous extract of iodine-containing plants on *E. coli* shows that the greatest antibacterial effect is exerted by rough cocklebur (inhibition zone was 29.8 mm, which corresponds to the action of such antibiotics as ceftriaxone and cefazolin) and *Potentilla alba* (19.3 mm, which is equivalent to the action of ampicillin and amoxicillin) [8]. Common duckweed shows an inhibition zone of 12.2 mm relative to *E. coli*, such activity can be compared with the action of carbenicillin and ticarcillin. The obtained results can be explained by the fact that *Potentilla alba* and rough cocklebur contain iodates in the composition of raw materials. Eelgrass, common duckweed and kelp have twice as less antibacterial activity. In relation to *St. aureus*, which can accumulate in the air of rooms with a high number of people, the greatest antibacterial

Table 2. Antibacterial property of fruit juices

Test microorganisms	Zone of inhibition (mm)		
	Vaccinium myrtillus	***Schisandra chinensis***	***Viburnum opulus***
P. vulgaris	12,1±0,3*	27,3±0,4*	13,2±0,3*
E. coli	10,2±0,1*	23,6±0,2*	7,4±0,4
Ps. aeruginosa	11,4±0,2*	22,1±0,2*	9,2±0,1*
St. aureus	-	14,8±0,1*	11,6±0,2*
C. albicans	8,4±0,5	-	12,1±0,2*

Mean values±standard deviation of five independent experiments (n=25). *p≤0.05 compared with control (water), significantly by Student's Test

Table 3. Results of iodine deficiency study

Respondent	Dependence of iodine deficiency on the duration of tea intake														
	Days of the experiment														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Placebo	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	1 (0%) 1 (50%) 18 (100%)
Zostera marina	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (0%) 18 (100%)	2 (0%) 18 (100%)	2 (0%) 18 (100%)	2 (0%) 18 (100%)	6 (0%) 14 (100%)	18 (0%) 2 (100%)	1 (50%) 19 (0%)
Potentilla alba	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	10 (0%) 10 (100%)	16 (0%) 4 (100%)	1 (50%) 19 (0%)
Xanthium stumarium	2 (50%)18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	10 (0%) 10 (100%)	16 (0%) 4 (100%)	1 (50%) 19 (0%)
Lemna minor	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (0%) 18 (100%)	2 (0%) 18 (100%)	2 (0%) 18 (100%)	8 (0%) 12 (100%)	15 (0%) 5 (100%)	15 (0%) 1 (50%) 4 (50%)	1 (50%) 19 (0%)
Laminaria saccharina	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	2 (50%) 18 (100%)	4 (0%) 1 (50%) 15 (100%)	10 (0%) 10 (100%)	1 (50%) 19 (0%)

"100%" is iodine deficiency; "50%" - partial iodine deficiency; "0" – the normal concentration of iodine in the body

activity was found in rough cocklebur, *Potentilla alba* and eelgrass. The action of iodine-containing plants on such as *P. vulgaris* and *Ps. aeruginosa* was found within the inhibition zone of 14-11 mm. Water extract of common duckweed, which has the highest copper content, showed the greatest fungicidal activity against *C. albicans*.

The results of the above-mentioned experiment allow us to recognize the magnolia berry juice the most effective against pathogen bacteria**.** It was showed the greatest antibacterial effect against *P. vulgaris* (zone of inhibition was 27 mm), which is similar to the effect of the antibiotic ceftriaxone [8]. *Schisandra chinensis* juice demonstrated antibacterial effects against *E. coli* and *Ps. aeruginosa* (inhibition zone was 23 mm and 22 mm in accordance). At the same time, the juices of fruit plants are inferior in their antibacterial activity against *St. aureus* to such iodine-containing plants as *Xanthium strumarium* and *Potentilla alba*. Guelder-rose showed the highest fungicidal activity among the studied fruit plants. Guelder-rose aqueous extract was effective against *St. aureus*. European blueberry aqueous extract proved to be a more effective antimicrobial agent against *E. coli*, *Ps. aeruginosa* and *P. vulgaris*.

Thus, the conducted experiment allows us to find out that the components of the phyto-aid kit in shelters should be the fruits of magnolia berry, guelder-rose, and among iodine-containing plants, the greatest antibacterial activity is characteristic of rough cocklebur and *Potentilla alba*.

When using nuclear weapons, one of the consequences is the contamination of the environment with short-lived radioactive isotopes of iodine. These isotopes can accumulate in the human body during the metabolism of the thyroid gland. Therefore, iodine-containing plant components can become a protection against the danger of radioactive iodine interference. In order to study the iodine-enriching function of plant components, we studied sea kelp, rough cocklebur, common duckweed, eelgrass and *Potentilla alba*. The results of these studies are presented in table 3.

According to the results of the experiment, all respondents of the control group had iodine deficiency during the 15 days of the experiment, except for one

Table 4. Reliability of iodine deficiency study

Measure 1	Measure 2	Criterion	Statistics	z	df	p	
PB	PA	Student	1.000		19	0.330	
		Wilcoxon	1.000	1.000		1.000	
LB	LA13	Student	2.333		19	0.031	*
		Wilcoxon	15.000	2.023		0.053	
LB	LA14	Student	4.158		19	< .001	*
		Wilcoxon	55.000	2.803		0.004	*
LB	LA15	Student	22.584		19	< .001	*
		Wilcoxon	210.000	3.920		< .001	*
RB	RA12	Student	3.390		19	0.003	*
		Wilcoxon	36.000	2.521		0.010	*
RB	RA13	Student	7.094		19	< .001	*
		Wilcoxon	120.000	3.408		< .001	*
RB	RA15	Student	22.584		19	< .001	*
		Wilcoxon	210.000	3.920		< .001	*
NB	NA13	Student	4.158		19	< .001	*
		Wilcoxon	55.000	2.803		0.004	*
NB	NA14	Student	8.110		19	< .001	*
		Wilcoxon	136.000	3.516		< .001	*
NB	NA15	Student	22.584		19	< .001	*
		Wilcoxon	210.000	3.920		< .001	*
PB	PA13	Student	4.158		19	< .001	*
		Wilcoxon	55.000	2.803		0.004	*
PB	PA14	Student	8.110		19	< .001	*
		Wilcoxon	136.000	3.516		< .001	*
PB	PA15	Student	22.584		19	< .001	*
		Wilcoxon	210.000	3.920		< .001	*
ZB	ZA13	Student	6.469		19	< .001	*
		Wilcoxon	105.000	3.296		< .001	*
ZB	ZA14	Student	12.254		19	< .001	*
		Wilcoxon	171.000	3.724		< .001	*
ZB	ZA15	Student	27.606		19	< .001	*
		Wilcoxon	210.000	3.920		< .001	*

PB - before placebo taking; PA- after placebo taking; LB – before Laminaria taking; LA13 - after 13 days Laminaria taking; LA14 - after 14 days Laminaria taking; LA15 - after 15 days Laminaria taking; RB – before Lemna taking; RA12 - after 12 days Lemna taking; RA13 - after 13 days Lemna taking; RA15 - after 15 days Lemna taking; NB - before Xanthium taking; NA13 - after 13 days Xanthium taking; NA14 - after 14 days Xanthium taking; NA15 - after 15 days Xanthium taking; PB - before Potentilla taking; PA13 - after 13 days Potentilla taking; PA14 - after 14 days Potentilla taking; PA15 - after 15 days Potentilla taking; ZB - before Zostera taking; ZA13 - after Zostera taking 13 days ; ZA14 - after 14 days Zostera taking; ZA15 - after 15 days Zostera taking.
*$p \leq 0.05$ compared with control (before), significantly by Student's and Wilcoxon's Tests

respondent who did not have iodine deficiency on the 15th day, which is an error of the study. When consuming *Zoster marine* tea, 10% of the respondents had symptoms of iodine deficiency disappear on the 9th day of the experiment, 10% on the 12th day, 70% on the 13th day, and 10% percent on the 14th day of the experiment, but in most respondents the signs of iodine deficiency disappeared on the 13th day of the experiment. When drinking common duckweed tea, signs of iodine deficiency disappeared on the 9th, 12th, and 15th days of the experiment in 20% of respondents, and in 40% of respondents on the 13th day of the experiment. When drinking kelp tea, 10% of respondents had symptoms of iodine deficiency disappear on the 11th and 12th day, 20% of respondents – on the 13th and 14th day, and 40% of respondents on the 15th day.

Table 5. Comparison of anxiety levels in people who consumed placebo or teas from different plants

Experiment option	Before		After	
	Level of reactive anxiety	Pulse	Level of reactive anxiety	Pulse
Placebo	38,2±8,1	77,2±9,0	38,0±6,1	78,3±9,0
Valeriana officinalis	41,3±5,4	80,3±15,1	36,4±9,1*	81,1±14,5
Borago officinalis	40,2±8,2	80,4±20,2	36,3±18,5	79,3±7,4
Crataegus ucrainica	40,1±5,3	80,1±10,3	37,2±3,1*	73,3±10,3*

*$p \leq 0.05$ compared with control (before), significantly by Wilcoxon's and Student's Tests

When drinking *Potentilla alba* and rough cocklebur, 50% of respondents had iodine deficiency symptoms disappear on the 13th day, 30% of respondents on the 14th day, and 20% of respondents on the 15th day.

Statistical analysis demonstrated the reliability of the data, which reveals the possibilities for the prevention of iodine deficiency.

All the studied plants have an iodine-enriching effect. *Zostera marina* and *Lemna minor* provide a greater rate of iodine enrichment.

The Spielberger-Hanin experimental results indicate that 16 out of 20 respondents who consumed valerian tea experienced a decrease in situational anxiety (from 3 to 13 units). On average, anxiety across the entire group decreased by 13% (Table 5).

Borage tea reduced situational anxiety indicators (from 1 to 12 units) in 14 out of 20 respondents, however with a certain increase in pulse rate in 14 out of 20 participants (from 3 to 13 units). Nevertheless, on average in the group that consumed Borage tea, the anxiety indicator decreased by 10%. Ukrainian hawthorn tea reduced situational anxiety indicators (from 3 to 8 units) in 18 out of 20 respondents, while also observing a decrease in heart rate in all respondents (from 2 to 12 units). However, the situational anxiety indicator in this group decreased by 8%.

Thus, it has been experimentally proven that all studied plants were effective for overcoming situational anxiety in shelter conditions, but the most effective is tea from Valerian roots (-13%) while maintaining heart rate. Borage tea reduces the situational anxiety indicator by 10% while maintaining the heart rate indicator. Under the influence of Ukrainian hawthorn tea, situational anxiety decreases by 8% while reducing the heart rate.

Statistical processing of the obtained data was performed using JASP software, and the reliability of the results was calculated using Student's and Wilcoxon's coefficients.

According to statistical analysis, some changes in the level of situational anxiety and pulse in individuals who took placebo are not statistically significant. This indicates the absence of suggestion effect on the experiment result. Data on the reduction of anxiety levels in individuals who consumed Valerian tea and Ukrainian hawthorn tea, as well as the reduction in heart rate, are statistically significant.

DISCUSSION

Our research demonstrates high activity of *Zostera* against *St. aureus*. Similar results were obtained by Choi H.-G., who also demonstrated high antibacterial activity of *Zostera marina* against *Streptococcus epidermidis* and *C. albicans*, and therefore suggests using this plant material to suppress skin pathogens [9]. Grujić-Vasić Jela et all [10] demonstrated high antibacterial activity of *Potentilla alba* against *St. aureus* and *C. albicans*, although our studies show no significant fungicidal effect against *C. albicans*. Antibacterial activity of aqueous and methanolic extracts of *Xanthium strumarium* was demonstrated in the work of Devkota A, the author emphasizes that the most sensitive bacterium is *St. aureus*, and the least sensitive is *E. coli* [11]. Our studies demonstrate a statistically significant inhibition of *St. aureus* growth (inhibition zone was 20 mm), and the absence of a statistically significant zone of inhibition for *E. coli*. The work of Perez MJ et all demonstrated high antibacterial activity of *Laminaria* against *E. coli, Salmonela typhimurium, St. aureus, Bac. cereus*, and we also observed a similar trend [12]. In the work of Esmail Ali Al-Snafi, high antibacterial activity of *Lemna minor* against *St. aureus* was demonstrated (inhibition zone was 25 mm) [13]; in our studies, the inhibition zone was 9.6 mm. The antibacterial properties of the above-mentioned plants are associated by the author with various substances, namely phenols, terpenoids, and others. We suggest that the antibacterial properties of these plants are also associated with iodine-containing substances.

In our work, *Schisandra chinensis* was effective against all studied microorganisms, such as *P. vulgaris, E. coli, Ps. aeruginosa, St. aureus*. Our work correlates with the Liya Song work, which also reveals the mechanism of this phenomenon. It turned out that the extract from *Schisandra chinensis* disrupts the functioning of *St. aureus* $Na^{+}\backslash K^{+}\backslash Ca^{++}$-ATPase [14].

We have demonstrated high antibacterial activity of aqueous blueberry extract against *P. vulgaris* and *Ps.*

aeruginosa. However, in the work of Miljkovic VM [15], high antibacterial activity of this plant was demonstrated against *Streptococcus epidermidis, Streptococcus pyogenes, P. mirabilis, and St. aureus*, which were isolated from purulent wounds. Nevertheless, Miljkovic VM concludes that there is a difference between the antibacterial activity against museum cultures and isolates from the human body. We have demonstrated high antibacterial activity of aqueous viburnum extract against *St. aureus* and *C. albicans*, which led to the widespread use of this plant for colds [16].

In our work, it was demonstrated that not only Laminaria, which was studied previously by Chi Y. S. [17], but also other plants can be used for the prevention of iodine deficiency, such as *Lemna minor, Potentilla alba, Xanthium strumarium,* and *Zostera marina.*

Among plants with a sedative effect, *Valeriana officinalis* proved to be the most effective. Unlike Ukrainian hawthorn, the use of an aqueous extract of this plant does not decrease the frequency and strength of heart contractions. Hattesohl M. argues that valerian, in addition to its sedative effect, also has an anxiolytic and antidepressant effect, which makes this plant an indispensable addition to a shelter phyto-aid kit [18].

CONCLUSIONS

1. The shelter phyto-aid kit should contain plants with antibacterial properties (preferably combined with an immunomodulatory effect), iodine-enriching plants, and calming plants.
2. According to research, the phyto-aid kit in shelters should be stocked with *Schisandra chinensis, Viburnum opulus and Xanthium strumarium* as antibacterial and antifungal agents.
3. *Zostera marina* and *Lemna minor* showed the highest iodine-enriching effect. It is rational to have dry herbs of *Zostera marina* and *Lemna minor* in the phyto-aid kit.
4. As a sedative, it is rational to include preparations or roots of *Valeriana officinalis* in the assortment of the phyto-aid kit.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

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