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1. FOOD SCIENCE AND TECHNOLOGIES

SPECIAL PURPOSE PRODUCT TECHNOLOGY FOR INCREASING THE PROTECTIVE FUNCTIONS OF THE ORGANISM OF SERVICEMEN WHEN PERFORMING TASKS IN EXTREME CONDITIONS

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Abstract. *Extreme conditions are exceptional, special, extraordinary circumstances in which a civilian or military person often has to act, which requires them to show high skills, independence, activity, creativity, perseverance and determination in action, and require maximum stress, which goes sharply beyond limits of physiological norm.*

According to the Ministry of Health of Ukraine, cold injuries in the overall structure of injuries range from 3 to 10% and are accompanied by disability and sometimes fatal. Annually, more than 12,000 cases of cold injuries in our country are registered. The problem is especially relevant given that fighting continues in the eastern Ukraine, in which the risk of cold injuries increases.

Researchers at the National University of Pharmacy found that amino sugar glucosamine hydrochloride (G g / x) has frigoprotective properties, in particular: reduces the degree of body temperature, improves motor activity, muscle tone and physical activity, cardiohemodynamics and rheological properties of blood in the conditions of cold injuries. In addition, its frigoprotective properties in combination with gelatin are increased. Therefore, to create a special purpose product for increasing the protective functions of the body of servicemen when performing tasks in extreme conditions, the technology of marmalade was chosen, the recipe of which introduced amino sugar glucosamine hydrochloride in a fixed mass proportion. It is proved that the obtained product improves the body's adaptation to long-term effects

of low temperatures and can be recommended as a frigoprotector when performing military service tasks in the field.

Keywords: *extreme conditions, cold injury, frigoprotector, glucosamine hydrochloride, marmalade.*

I. INTRODUCTION

In the scientific literature and departmental legislation, the issue of a person's ability to perform his or her duties in situations where his or her life and health are in danger.

Under extreme human activities are all actions aimed at preserving life, health and ability to work in extreme environments. These actions depend on a person's ability to withstand psychological stress, show ingenuity, effectively use available equipment and tools to help victims, self-help, protection from the adverse effects of the environment, to meet the needs of their own body.

In listing all the dangers to human health and life, climatic conditions play an important role, condition of environment, food supply and their value, socio-economic and medical conditions, conflicts, etc.

Scientific research has identified one of the main types of extreme conditions – it is physical (heat, cold, etc.).

The initial value of energy has a significant impact on the ability of the unit to perform a combat mission in extreme conditions, which is accumulated in the body of each serviceman and the provision of personnel with food that has protective properties. This provides a basis for identifying and studying another component of the combat potential of units of the so-called bioenergy potential.

The importance and expediency of the work is due to the absence on the market of Ukraine of special purpose products that have a frigoprotective effect and can be used by military personnel in the performance of combat missions in extreme conditions. Therefore, the development of technology for a special purpose product – marmalade containing the amino sugar glucosamine hydrochloride, to increase the protective functions of the body of servicemen when performing tasks in extreme conditions is relevant and important.

Approbation of research results was discussed at scientific and practical conferences, including international ones.

II. LITERATURE ANALYSIS

In modern conditions to improve the functional and technological properties, increase the nutritional and biological value of food products use a variety of food and dietary supplements: antioxidants, emulsifiers, preservatives, thickeners, isolates, meal, bran, whey and others [15]. The current issue of improving the food security of the Armed Forces and other military formations is the development and implementation of scientific advances in food technology, food hygiene, medicine, pharmacology to increase human adaptation mechanisms to environmental factors, including cold injury [17 - 19]. Scientists are very interested in the prevention of cold

injuries are special products based on antioxidants of plant origin, natural proteins, carbohydrates and amino sugars.

Glucosamine hydrochloride in a dietary supplement has been shown to help restore connective tissue and improve muscle circulation [3, 5, 7, 9]. It is this property of glucosamine hydrochloride is enhanced in its combination with gelatin (which is essentially hydrolyzed collagen), as it reduces the degree of destruction of active substances in the gastrointestinal tract and increases its degree of absorption [3, 5 - 7, 9]. The role of collagen at first glance may seem insignificant, because it is a simple chain of amino acid residues, in addition, it does not have a complete set of essential amino acids, respectively, and the body can synthesize it on its own. It also contains no vitamins or trace elements. However, the fact is that when you eat ready-made collagen with food or in the form of special dietary supplements such as glucosamine, it does not need to be divided into individual amino acids to be absorbed into the blood from the intestine, it gets there in the form of oligopeptides. These are ready-made whole chains with the correct amino acid sequence for the synthesis of their own collagen. In addition, another advantage is the ability to bind water molecules, which increases the hydrophilicity of tissues, their recovery, improves blood circulation [5 - 7]. This is an important argument in the development of technology for a special purpose product with frigoprotective properties [9 - 11, 13 - 15].

In addition, glucosamine hydrochloride is a non-toxic metabolic agent. In its structure it is an amino sugar, it is one of the most important structural components of the body, the content of which in tissues in many diseases varies, in addition, it is an important precursor in the biochemical synthesis of glycosylated proteins and lipids. Glucosamine derivatives have polymodal pharmacological properties, including anti-inflammatory, membrane stabilizing, antioxidant, frigoprotective, cerebroprotective, nootropic and others.

Glucosamine is found in many foods and can also be synthesized chemically. The daily requirement of glucosamine for an adult is at least 700 mg / per day, so to obtain a sufficient amount of glucosamine it is necessary to consume it in the form of chondroprotective drugs, or bioactive dietary supplements.

Our choice of confectionery – marmalade to develop the technology of a special purpose product is because its prescription composition includes gelatin, it has a high-energy value, which is important in cold injuries, has a long shelf life and convenient packaging.

III. OBJECT, SUBJECT AND METHODS OF RESEARCH

From the point of view of the problem of cold injury of servicemen who perform tasks in extreme conditions, the participants of the educational-scientific-industrial cluster "Complete nutrition: energy-efficient production, storage and marketing" formulated the task – to develop technology for a special purpose product with ingredients in its recipe to increase the body's adaptation mechanisms to environmental factors.

The requirements for the product were extended shelf life, convenient packaging, aesthetics, high energy and nutritional value.

The subject of research – amino sugar glucosamine hydrochloride, dietary supplement "Glucosamine-C BHFZ" (BHFZ, Ukraine), jelly marmalade for special purposes, which has frigoprotective properties.

The object of research is the technology of jelly marmalade.

Research methods, in particular: statistical, situation modeling methods, branch and special physical, microbiological, organoleptic.

The statistical method was used in the analysis of military personnel 'performance of combat missions in extreme situations. Statistical data processing was performed using the program "Statistica, V. 6.0". The modeling method was used during the creation of extreme conditions in preclinical studies. The method of experimental research is used to confirm theoretical positions in practice. The use of such a wide range of methods causes, firstly, a fairly high validity and reliability of the results, and secondly, forms a rich array of primary scientific material, so the conclusions and results are objective.

IV. RESULTS

Scientists of leading universities of Ukraine within the cooperation of educational-research-production cluster "Complete nutrition: energy efficient production, storage and marketing", which includes, in particular, Kharkiv State University of Food Technology and Trade, The National University of Pharmacy and The National Academy of the National Guard of Ukraine, developed technology of an innovative special purpose product containing a functional ingredient – amino sugar. This is a confectionery product – marmalade, which contains a compound of glucosamine hydrochloride, which according to a set of criteria is a frigoprotector, which is reflected in publications [12 - 14].

As a result of the conducted researches the compounding of a product of a special purpose is developed – jelly marmalade, which includes amino sugar (glucosamine hydrochloride) in the required mass fraction.

Raw materials for the preparation of jelly marmalade are sugar, apple puree, citric acid and molasses. The choice of apple puree is justified by the fact that the pectin substances of apples are traditionally used in the production of fruit jelly marmalade.

The use of citric acid as an acidity regulator is due to the fact that apple puree contains a very small amount of organic acids. Citric acid has a softer, pleasant, sour taste and, unlike other food acids, does not have an irritating effect on human mucous membranes.

Preparation of raw materials is as follows:

Granulated sugar is sifted through a sieve with holes with a diameter of 3 mm. The molasses is heated and filtered through a sieve with holes 1,5 mm in diameter. Apple puree is rubbed through a sieve with holes with a diameter of 0.8-1.0 mm. The acid dissolved in water in a ratio of 1:1 is filtered through two layers of gauze. Gelatin is soaked until completely swollen.

Pour water into the pot, add sugar, dissolve, cook at a slow boil for 5-7 minutes and add molasses and apple puree. The boiled syrup is filtered through a sieve with holes with a diameter of 0,5 mm. Add swollen and water-dissolved gelatin and bring to a boil with stirring.

Into ready finished jelly-sugar syrup at a temperature of 65 °C add a solution of citric acid and dissolved in water amino sugar (glucosamine hydrochloride) in an amount of 0,015 kg per 1 kg of finished product.

Chilled to 50-55 °C jelly mass is poured into molds and stand 45-60 minutes at this time, jelly is formed and the jelly mass is cooled. After aging, the marmalade is removed from the molds and sprinkled with granulated sugar.

Marmalade is dried in dryers at a temperature of 40 °C to a humidity of 18-20%. In the absence of a dryer marmalade is dried in the shop for 10-12 hours. The dried marmalade is placed in a paper corrugated capsule.

Figure 1 shows the technological scheme of production of jelly marmalade with the addition of the amino sugar glucosamine hydrochloride.

Feature of the proposed technology of jelly marmalade with the addition of amino sugar glucosamine hydrochloride is that at the stage of bottling in jelly-sugar syrup add water-soluble glucosamine hydrochloride.

It is planned to make marmalade unwrapped, piece by piece. The weight of one piece of marmalade is 31 g, which contains 500 mg G g / h, which at three times a day is 1500 mg and corresponds to the range of daily doses of 1000-1500 mg.

Piece marmalade is packed in cellophane, polymerized metal films approved for use by the Ministry of Health of Ukraine. No more than four rows of marmalade are placed in set.

The quality of marmalade was determined by organoleptic, physicochemical, microbiological and safety indicators.

Organoleptic characteristics of jelly marmalade with the addition of glucosamine hydrochloride, taste, smell, color, texture, surface, shape were determined at working tastings. Taste and smell are crucial in the organoleptic assessment of marmalade quality. The data are shown in table 1.

Table 1. Organoleptic characteristics of jelly marmalade with the addition of glucosamine hydrochloride

Name of Indicator	Characteristic
Taste, smell	Characteristic of apple marmalade without foreign taste and smell
Consistence	Gem-shaped, elastic
Shape	Correct, with a clear contour, without deformation.
Surface	Sprinkled with granulated sugar without signs of sugar dissolution, without leaks, cracks, graying

As can be seen from table 1, the addition to the marmalade formulation of jelly glucosamine hydrochloride does not affect the organoleptic quality of marmalade.

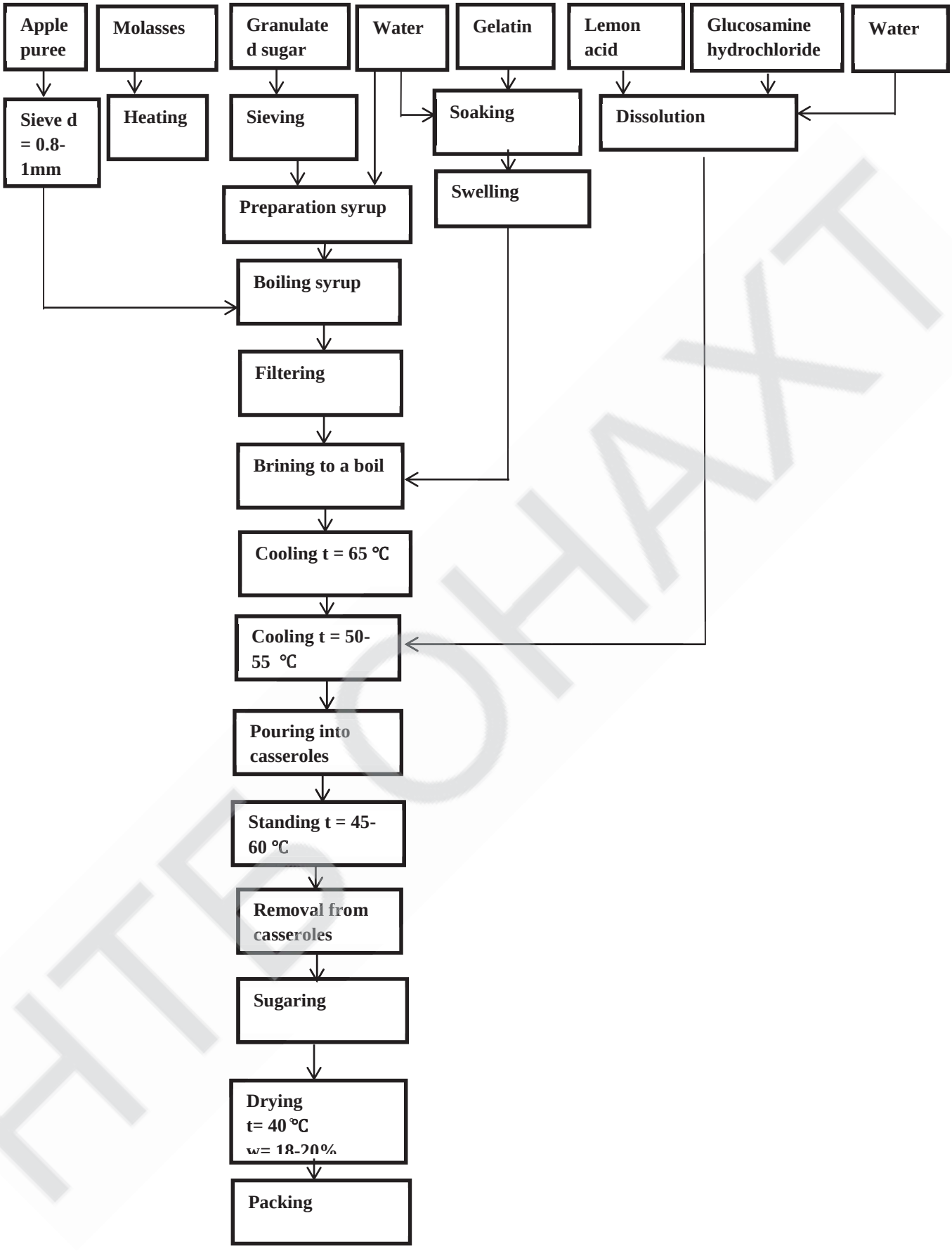

Fig. 1. Technological scheme for the production of jelly marmalade with the addition of glucosamine hydrochloride amino sugar.

Table 1. Organoleptic characteristics of jelly marmalade with the addition of glucosamine hydrochloride

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Physico-chemical parameters of marmalade with glucosamine hydrochloride are given in table 2

Table 2. Physico-chemical parameters of marmalade with glucosamine hydrochloride

Name of Indicator	Norms for the NSU	Jelly marmalade with glucosamine hydrochloride
Mass part of moisture,%	no more 24	21,8
Mass part of reducing substances,%	no more 25	21,11
Mass part of total sugar,%	No less 65	68,3
Total acidity, degrees	7,5 - 22,5	17,1
Mass part of ash insoluble in 10% hydrochloric acid solution,%	no more 0,05	Not found
Total ash,%	No rationed	0,08

As can be seen from table 2, the mass part of moisture in the samples does not exceed the standard for fruit jelly marmalade. The amount of reducing substances is also within the norms of the standard.

Acidity in marmalade with glucosamine hydrochloride is mainly due to the introduction as a regulator of the acidity of citric acid.

The mass part of ash, insoluble in 10% hydrochloric acid solution, in marmalade was not found, which indicates the purity of raw materials and finished product.

From the above it follows that the physico-chemical parameters of marmalade with glucosamine hydrochloride is in accordance with the norms of pure standards.

Microbiological parameters of jelly marmalade with the addition of glucosamine hydrochloride in comparison with the control are shown in table 3 [20].

Table 3. Microbiological parameters of jelly marmalade with the addition of glucosamine hydrochloride in comparison with the control

Name	The number of mesophilic, aerobic and facultative anaerobic microorganisms, CFU in 1 g, not more than	Mass of product (g / cm3) in which Bacteria of the Escherichia coli group (coliforms) are not allowed	Pathogenic microorganisms, in particular bacteria of the genus Salmonella	Molds, CFU in 1 g, no more	Yeast CFU in 1 g, no more
Fruit and berry jelly marmalade (control)	$1x10^3$	0,1	Not allowed	50	25
Marmalade with the addition of glucosamine hydrochloride	$2x10^2$	Not found	Not found	15	Not found

Data from microbiological analysis of marmalade samples showed that in all respects they meet the requirements of the NSU. This is due to a set of measures to create and maintain a sanitary and hygienic regime in the production of marmalade.

The warranty period of the special purpose product of marmalade is 3 months.

Previous preclinical studies of NUP scientists have established the effect of a new special purpose product – jelly marmalade with the addition of the amino sugar glucosamine hydrochloride, on body temperature and the state of the central nervous system of rats after a cold injury. The results of the studies revealed that marmalade with the addition of glucosamine hydrochloride compound contributed to a significant increase in body temperature relative to the control group. This figure was almost the same as in the intact control group. Conventional jelly marmalade (control) significantly increased this rate relative to CG, but had a significantly lower effect on the group of intact control and marmalade with the addition of glucosamine hydrochloride.

In accordance with the purpose of our work to obtain objective results that the special purpose food marmalade with amino sugar can be recommended to increase the body's resistance to cold, we created three groups of servicemen of the National Academy of the National Guard of Ukraine who voluntarily expressed a desire to participate in scientific research. The approbation of experimental samples of marmalade with the addition of amino sugar glucosamine hydrochloride was carried

out, at the suggestion and advice of the staff of the National University of Pharmacy – a doctoral student of the Department of Pharmacology, c.p.s., E. Bondarev and Head of the Department of Pharmacology, d.m.s., prof. S. Shtrigol.

The study involved 30 cadets (men 18-20 years), who were in hospital for 2 weeks in February 2018, where they performed the following tasks: training, guard duty, physical morning training in the fresh air (the temperature in this period ranged from -2 to -15 ºC).

The cadets were randomly divided into 3 groups:

Group I – servicemen who took marmalade with the addition of glucosamine hydrochloride 3 pieces 3 times a day (10 cadets). Weight of 1 piece of marmalade 31 g. Total weight – 93 g per day. The content of glucosamine hydrochloride in the daily norm of marmalade is 1.5 g.

Group II – servicemen who took the same placebo – the same marmalade, but without the active substance (10 cadets).

Group III – control, which did not accept any of the above (10 cadets).

Fruit jelly with glucosamine hydrochloride compound was offered by voluntary consent to all participants in the research.

Before and after the research (during February 2018), all voluntary participants were assessed for their health: body temperature, blood pressure, heart rate, general blood test, dynamometry. A correction test was used to analyze the ability to concentrate, its stability and exhaustion. The number of cases of acute respiratory viral infections was recorded, which is facilitated by the effects of low temperatures. All studies were performed in a warm room (temperature + 22…23 °C) immediately before and for 14 days – on the last day of the study.

The schedule of taking special consumption products was worked out and recommended: marmalade with the addition of amino sugar G and placebo was taken 1 piece 3 times a day after meals. In group 1 on the background of marmalade with the addition of glucosamine hydrochloride compound, the study was completed by all cadets. There were no cases of SARS, which in comparison with the data of group 2 is statistically significant ($p<0,05$) indicates the protective effect of the studied drug. Body weight did not change significantly. The body temperature of the cadets of this group did not change, erythrocyte sedimentation rate increased by 21,3 %, which is significantly less ($p<0,01$) compared to the corresponding figure in group 2. No significant effect on physical strength was found, but there was a slight increase in strength in both the right and left hand by 5,6 % and 3,2 % relative to the original data. The state of SSS was not significantly affected by marmalade with glucosamine hydrochloride, except for a moderate increase in heart rate from 60,7 ± 1,0 to 64,2 ± 1,2 beats / min., which can be regarded as an adaptive response to the action of low temperatures. The clinical blood test revealed a significant increase in white blood cell count ($p <0,05$) and a slight increase in hemoglobin compared to baseline. These data are normal, and their moderate increase may be due to exercise and cold during the study.

According to the results of the proofreading test (KP), an increase in the number of revised characters by an average of 21,8 % indicates an improvement in mental performance. The number of errors decreased by 19,5 %, indicating an improvement

in the concentration of attention in the cadets of this study group.

In group 2, all cadets completed the study on the background of placebo. The cadets of this group did not change their body weight. Moderately but statistically significant ($p<0,05$) increased body temperature (by 0,4 %) and ESR (by 30,3 %), which is significantly higher than the corresponding indicators of group 1. These results may indicate the development of inflammatory reactions in response to the effects of low temperatures during morning workouts, service in custody. Statistically significant ($p <0,05$) increased hemoglobin level (by 1,1 %) relative to baseline. No significant effect on blood pressure and heart rate was detected. There was a significant increase in muscle strength in both the right and left arm. The largest increase in the dynamometry index for the left arm (by 16 %) is associated with a pronounced training effect against the background of a low initial value. The results of KP show that in the placebo group to a lesser extent than on the background of marmalade with the addition of amino sugar glucosamine hydrochloride has undergone adverse changes in mental performance: the number of viewed signs increased by an average of 11,7 %, but the number of errors on day 14 increased by 13, 8% against the initial level. This figure is significantly higher than in group 1, where the number of errors decreased. The results indicate a decrease in concentration, lack of concentration in placebo cadets during the study.

In group 3, which did not take any of the products offered, the study was completed by 7 cadets out of 10,3 % had SARS. There were no significant changes in body temperature, blood pressure (BP), heart rate (HR), general blood test, dynamometry. The ability to concentrate and resistance to exhaustion has not changed significantly.

The generalization of the results shows that in the two groups there was a significant increase in the level of leukocytes ($p<0,05$) and a slight increase in hemoglobin compared to baseline. These data are normal. It is significant that the degree of growth of the studied indicators depends on the initial state. A more pronounced increase was observed in servicemen of group I.

Table 3 shows comparative data on the effect of marmalade with the addition of the amino sugar glucosamine hydrochloride on the physical condition, shows the indicators of cardiohemodynamics, body temperature, hemogram in cadets in the conditions of winter field training.

Table 4 shows comparative data on the effect of marmalade with the addition of the compound glucosamine hydrochloride on the mental abilities of cadets in the conditions of winter field training.

Thus, the obtained data allow us to conclude that the special purpose marmalade with amino sugar glucosamine hydrochloride in cold injury effectively prevents hypothermia, improves the CNS and can be recommended in the daily diets of Ukrainian servicemen as a special food to enhance the body's defenses.

- during the period of service and combat missions in extreme conditions;

- to improve well-being, concentration, increase the mental capacity of servicemen (actoprotective effect);

- increasing the nutritional and biological value of the daily diet of servicemen due to easily available carbohydrates, the content of essential amino acids and vitamins.

A new product received a patent for a utility model № 139162 dated 26.12.19, "Method of making marmalade containing glucosamine hydrochloride and exhibiting frigoprotective properties

V. CONCLUSIONS

1. The technology of a special purpose product of jelly marmalade with the addition of the amino sugar glucosamine hydrochloride has been developed. It is established that according to organoleptic indicators, safety indicators, conditions and terms of storage the new product meets the requirements of regulatory documentation.

2. It was found that the use of a special purpose marmalade product containing glucosamine hydrochloride in a two-week exposure to low ambient temperatures during winter field training in cadets significantly reduces the risk of acute respiratory diseases (from 12,5 % to 0 %, $p<0,05$) , reduces ESR, which indicates anti-inflammatory effect, improves the body's adaptation to prolonged exposure to the cold factor, in the test "proofreading" increases concentration (by 19,8 %) and mental performance (by 22,7 %). That is a powerful frigoprotector.

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