

# Increasing the Adaptive Capacity of the Organism When Exposed to Adverse Environmental Factors Through Phytoadaptogens

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**Abstract.** The Problem of improving the quality of life of the population in modern conditions is the most relevant. The level of human health largely depends on the quality of the environment. Of special importance are the risk factors for the spread of diseases like environmental pollution, social conditions and bad habits. To the emergence of ecologically dependent diseases leads the combined impact of technogenic, social-economic, natural-climatic factors. The introduction of the principles of biotechnology, nanotechnology and innovations in industrial processing of plant resources, especially natural adaptogens, contributes to the production of balanced, ecologically clean food products functional purpose, the use of which will significantly minimize the adverse effects of the environment on humans.

## 1. Introduction

Today, human activity gets out of geo-ecological processes leads to a change in the natural biogeochemical cycles on earth, the violation of the ecological balance in the biosphere that in turn affects the man himself. The food chain get alien non-food components, which can lead to the development of a number of ecologically dependent diseases: allergies, malformations, mutational changes, intoxications, tumors, etc.

The last led in the present, the shift from environmental protection to protection of human health as the main resource and engine of progress. The level of human health largely depends on the quality of its habitat. Environmental factors 18-20% determine the health status and are in second place after lifestyle.

The lack of effectiveness of existing means for the prevention of ecologically dependent diseases, necessitated the creation of new types of functional products. Development and production of food products with functional properties, is a global trend. The production of functional products allows efficient use of nutrients as a source of energy and plastic material for various organs and systems to



maintain the native biologically active substances, to reduce the content of substances which have a toxic effect on the body.

Throughout the history of mankind wild plant raw materials used for cooking a variety of preventive tools that can stimulate the body's defenses and thereby enhance its performance as a result of their actions are activated functions of organs and systems [1]. This effect can be achieved with the help of stimulant drugs – adaptogens. The action of these substances on the processes of cellular metabolism is the synthesis of structural substances and of energy-rich compounds. The result is a physiological mobilization of protective forces. These substances, expanding bottlenecks metabolism, prevent the violation of the energy and plastic processes in the tissues. They are capable of long time to maintain under extreme conditions, the constancy of the internal environment that, according to conventional ideas is a prerequisite for healthy existence of the body. The ability of substances to activate the body's defenses and thereby enhance their resistance to extreme agents gave the reason to allocate them in separate group – adaptogens.

The development of the production of functional foods based on natural adaptogens - the most important scientific direction, based on the current understanding of the physiology of adaptation, homeostasis, regulations for biological Cybernetics and the theory of functional food. The most significant trend in these studies is the development of approaches, criteria and methods to assess adaptive capacity of the organism.

## 2. Review and Analytics

Natural adaptogens enhance mental performance, improve psychomotor activity, humoral immunity.

When using drugs ginseng (lat. *Panax zingiberensis*) and Siberian ginseng (lat. *Eleutherococcus*), the reduction of the expenditure of muscle glycogen, lactate content increased to a lesser extent. The positive effect of *Rhodiola rosea* (lat. *Rhodiola rósea*) and *Eleutherococcus senticosus* (lat. *Eleutherococcus senticosus*) in exhausting muscular exertion associated with their stimulating effect on the plastic exchange, resulting in the increase in muscle RNA. High efficiency has *Schisandra chinensis* (lat. *Schisandra chinensis*) increase the body's resistance to hypothermia, physical and mental stress, and various types of rose hips, which have a beneficial effect on the human body [2, 3].

A kind of plant adaptogens, the so – called biostimulants, which include the extract from the aloe leaf (lat. *Áloë*), juice of stems of *Kalanchoe* (lat. *Kalanchoë*), etc.

According to some researchers [5, 6], the pharmacological effect due to the presence of saturated and unsaturated aliphatic dicarboxylic acids, aromatic phenolic acids and other natural compounds.

Herbal adaptogens reduce the severity of the lesions with ionizing radiation and emotional stress, applied in the complex treatment of debilitated patients who have reduced body resistance, in cancer patients, to enhance physical stamina in athletes and mental health, in occupational exposure, during work in hot shops, in conditions of lack of oxygen in the atmosphere, and at high concentrations of toxic substances in the air of working zone [5].

Adaptogens have a mild but steady antihypoxic and antioxidant action.

It is proven that stress can contribute the development of hypertension in genetically determined or caused by other factors, the inadequacy of mechanisms of regulation of water-salt metabolism and vascular tone. Based on the study of the literature found that 2/3 of people cancer diseases in the next 2-4 years before the disease experienced severe stress caused by prolonged depression [7].

Adaptogens can cause and support the body's need adaptive response to increase resistance in each case. Such versatility is determined by the ability to adjust for stress reactions [8]. In the absence of stress on the background of a relatively normal condition of the body was also highlighted certain effects of adaptogens expressed to a lesser degree. However, the value of adaptogens on the body is extremely large, since we are talking about creating in the body with adaptogens a "margin of safety" - provision of health, which is crucial for disease prevention [9].

In this respect, of particular value represent multicomponent mixture of vegetable raw materials, in which consider three rules: a tonic effect, stimulating effect and influence on the particular disease,

which can be regarded as one of the major factors contributing to the increase of nonspecific resistance of the organism.

The aim of this work is the development of principles of creation of new kinds of functional drinks based on adaptogens from plant material grown in the territory of the Russian Federation and the practical approbation of the proposed methods.

### 3. Results

A special role in the practice of healthy eating is given to drink, considering their popularity among the population, an enrichment of biologically active substances for various applications.

Certain priorities in the production of enriched drinks is the use of medicinal vegetative raw materials, containing in its composition a wide range of substances pharmacological selectivity [9].

To implement the process of development and implementation of enriched product can only be based on clearly defined, scientifically based and proven medical and biological principles that determine the most significant issues of the development, production and sales, vitamin-enriched foods.

When designing one of the important tasks of the food systems is ensuring the optimal set and the ratio RX of the components for the development of new functional foods, including beverages for various categories of the population.

In the present work supplemented by, principles of design of functional beverages, the methodology for the production of healthy food developed N. N. Corneum, E. P. Viktorova, O. V. Evdokimova [10].

The application of the proposed principles in practice allows to exclude empirical approach in the search for raw materials and determine various aspects of feasibility of the combination by calculating the participation criteria of the individual components of the formulation in the formation of quality new products.

This principle makes it possible to rank the product components according to their contribution to the properties of the whole structure, to propose both analytical and synthetic conclusion, to assess their relationship.

The main design principles of the drinks based on natural adaptogens is presented in figure 1.

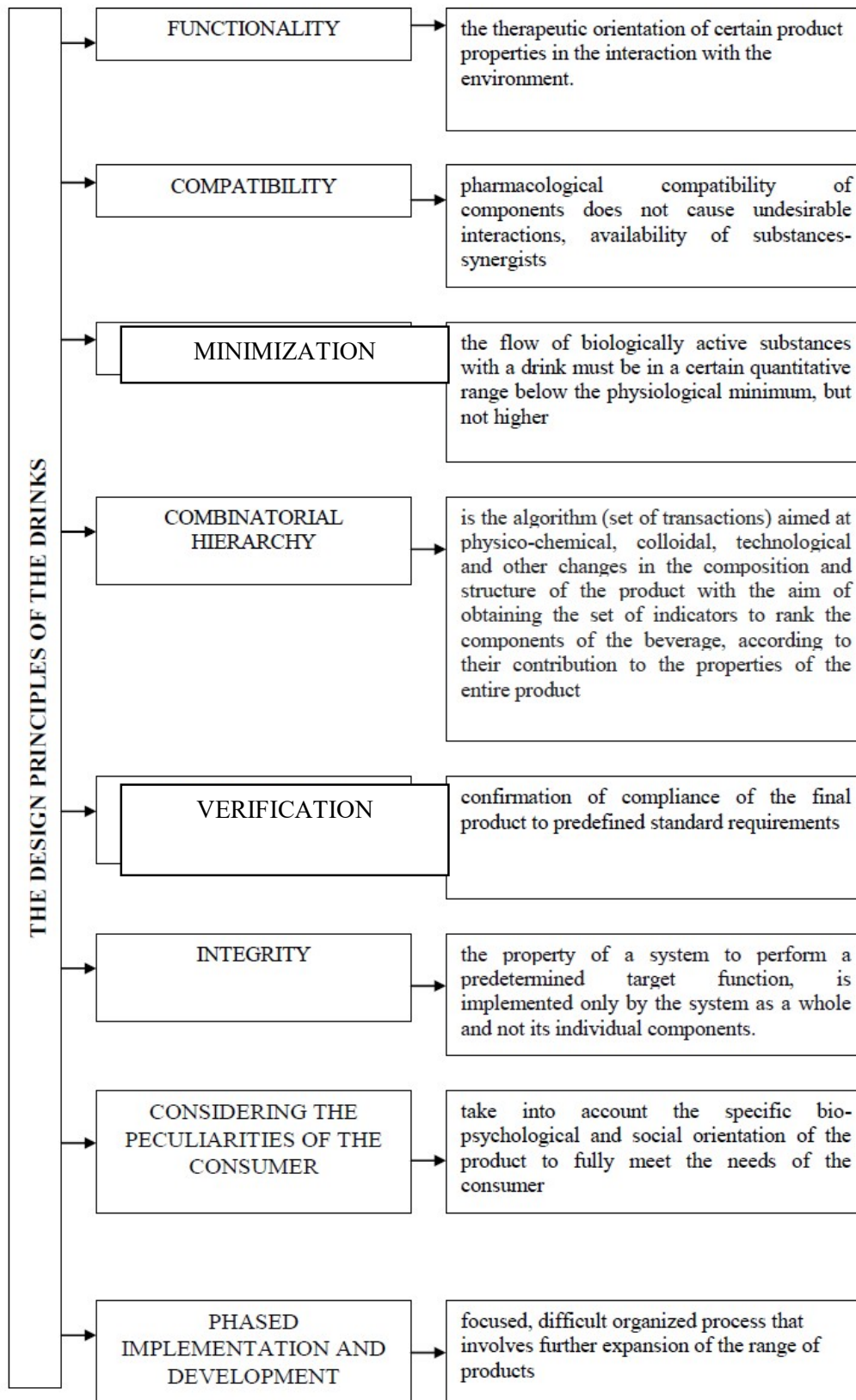
The principle functionality is a fundamental attribute of the system. Any system interacts with the environment, i.e. has a certain set of functions. This principle is based on the therapeutic orientation of certain properties of the drink as a prophylactic measure.

The principle of compatibility takes into account the pharmacological compatibility of recipe components do not cause undesirable interactions, availability of substances-synergists to achieve private goals, such as persistence, indicators of quality, including sensory characteristics, the optimum composition of the product, absorption.

The principle of minimization. The prosperity of the human body depends on a complex of factors, each of which organism there is a certain range of tolerance. Tolerance occurs when repeated administration of a given amount of a substance causes a reduced effect or when to obtain the effect previously achieved smaller dose requires a consistent increase in the number of administered substances.

Thus, this principle is considering the possibility of receipt of biologically active substances in the human body with the product (including a drink) in a specific quantitative range below the physiological minimum, but not above the recommended standards and is based on the recommended levels of food consumption and biologically active substances.

The principle of the combinatorial hierarchy the entity is in the set of operations aimed at physico-chemical, colloidal, technological and other changes in the composition and structure of the product with the aim of obtaining the specified performance.



**Figure 1** – Basic design principles based drinks natural adaptogens

The principle of verification be to ensure that the confirmation of compliance of the final product must conform to predefined standard requirements.

The principle of integrity involves the separation of the object of study of holistic education, i.e., distinguish it from other phenomena, from the environment. This can only be done through the identification and evaluation of the characteristics of phenomena and comparison of these properties with the properties of its elements.

The principle of the personal characteristics is the need to identify and address the BIO-psychological and social orientation of the product to fully meet the needs of the consumer (age, gender, working conditions, and price preferences of the user, the purpose of the application of the product).

The principle of gradualism and development is a purposeful, difficult organized process in which there are different stages. Each of them has its objectives, tasks and methods of correction. Consistently formed the preconditions for expanding the range of products (including by and drinks). The range of products will cover all segments of the population and to ensure the effectiveness of the prevention of various diseases.

#### 4. Practical approbation of the developed methods

One of the options for obtaining functional beverages can be fermented beverages obtained as a result of unfinished alcohol and/or lactic acid fermentation of kvass wort concentrate or fruit and berry musts. Thus, in the development of technologies new types of functional beverages, the starting point was the technology popular in Russian Federation bread fermented beverage – kvass.

As an adaptogenic basis for the preparation of functional beverages used an extract of schisandra chinensis (lat. *Schisandra chinensis*), Siberian ginseng (lat. *Eleutherococcus*), concentrated juices of black currants (lat. *Ribes nigrum*) and Apple juice (lat. *Mālus*).

The result of extraction of biological components go into solution and become more accessible and digestible. But, as vegetable raw material (*Eleutherococcus*) is significantly different from the schisandra fruit, it is considered appropriate to investigate the extraction process separately for each type of raw materials used. The first stage of the research was the selection of the extractant. Any extractant was selective, chemically and pharmacologically (from the point of view of security) to be weak, to be available and cheap.

Infusion of *Eleutherococcus* carried out with water for 30-120 min at ratio raw material:extractant 1:50-1:100. In the obtained extracts was determined biologically active substances to the main component - eleuterozida B (table 1).

**Table 1** – Influence of parameters of the extract of *Eleutherococcus* on eleuterozida B

The conditions of extraction	The contents of eleutheroside B in % when the ratio of raw materials-extractant	
	1:50	1:100
120 min	0.061	0.063
60 min	0.057	0.059
30 min	0.059	0.057
4-fold extraction for 30 min.	0.064	0.064

Comparison by Student's t test and Fischer ( $P=0.95$ ) showed no significant influence of selected parameters of the methodology on the results of the analysis ( $F_H < F_{kr}$  and  $t_{it} < t_{kr}$ ). In light of this methodology was chosen extraction time of 30 minutes. The optimal ratio of raw materials-extractant is 1:50.

Extract of Siberian ginseng increases endurance, performance and participates in toning the body, but also positively affects the mental and physical activities.

Extracts of *schisandra chinensis* were prepared, taking into account the coefficient of water absorption, which was determined experimentally. For the preparation of infusions used chopped dried raw material passing through a sieve with a hole diameter of 2 mm. the Experiment was conducted on 4 samples subjected to one form of drying: convection, infrared. In a series of pilot experiments were the optimal parameters of extraction: duration of 6 h, temperature 35 0C, the extractant 1:10 with occasional stirring of the mixture at intervals of 30 minutes. The duration of extraction for six hours due not only to output the maximum number of biologically active components, but also the "ripening" of the extract, expressed in the formation of the fullness and harmony of taste. The main components of the extract having biological activity are polyphenolic nature, in this regard, the emphasis in the analysis of biologically active substances (BAS) were made on these compounds [10]. The content of biologically active substances in the water extract from dried fruits of *schisandra chinensis* obtained by convective drying (table. 2).

**Table 2** – Content of biologically active substances in the extract from the fruit of *schisandra chinensis*

The method of drying	The content of biologically active substances, %			
	tannins	phenolic compounds	anthocyanins	organic acids
Natural	0.021	0.008	0.0015	1.26
Convective	0.085	0.025	0.0072	2.18

As can be seen from the above data, the content of biologically active substances in the extracts obtained from fruits dried by convective method, 2 - 4 times higher than naturally dried.

The obtained data confirm that the selected extraction parameters are optimal, because they retain the maximum number of biologically active substances (80-93 %) for all analyzed indicators.

The obtained extracts have a high nutritional value and can be used as sources of biologically active substances upon receipt of the drinks of a functional purpose.

The authors developed a recipe and technology of kvass functional purpose, allowing their use with minimal time to adapt to adverse environmental factors.

Qualitative and quantitative composition of the components kvass was determined by sensory characteristics, and taking into account recommended standards of the contents of biologically active substances in the finished product.

The quantitative composition of the components kvass is given in table 3. To increase the vitamin value in the sample No 1 was added concentrated black currant juice, and in sample No 2 – concentrated Apple juice.

**Table 3** – Consumption of the components per 100 dm<sup>3</sup>

Name of raw materials	Sample 1	Sample 2
Kvass wort concentrate, kg	28.6	28.6
Sugar, kg	50	50
Yeast, kg	0.15	0.15
Extract of <i>schisandra chinensis</i> , dm <sup>3</sup>	1.2	-
Siberian ginseng extract, dm <sup>3</sup>	-	1.2
Concentrated black currant juice, dm <sup>3</sup>	0.3	-
Juice concentrate Apple juice, dm <sup>3</sup>	-	0.3

Fermentation was carried out in different ways: using only the yeast Fermipan soft; yeast Fermipan soft together with dressing Ultravit; lactic acid bacteria (*bulgaricus*) together with a yeast feeding Ultravit and mixed ferment with Baker's yeast Fermipan soft (0.025 %) and lactic acid bacteria (*Bulgarian Bacillus* 0.015 %). Dosage of insertion of yeast and lactic acid bacteria were established on the basis of recommendations for their use in the production of kvass.

The fermentation was conducted at 30 °C to a solids content of 5 %. The dynamics of the digestion process are shown in figures 2 and 3.

From the data presented in figures 2 and 3 shows that the fermentation process proceeds most intensively during the fermentation the yeast mixture and nitrogen top-dressing "Ultrafit", as well as yeast feeding and lactic acid bacteria (48 hours).

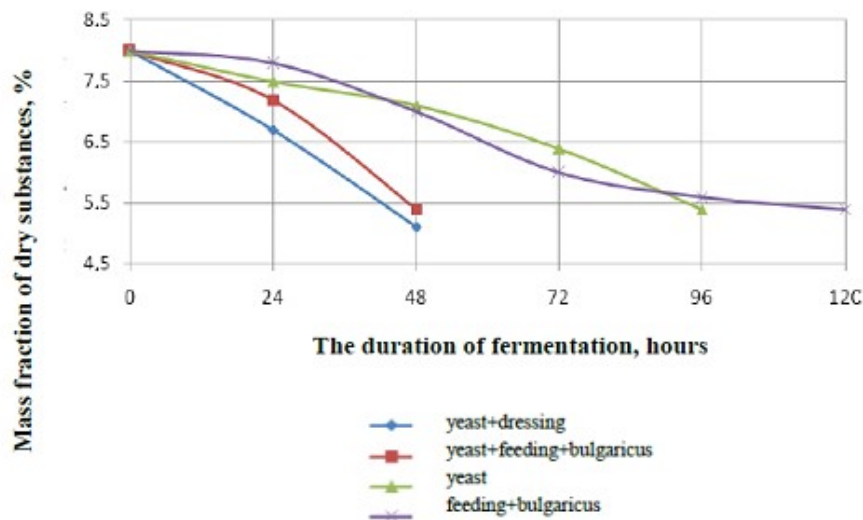


Figure 2 – Dynamics of digestion model No 1

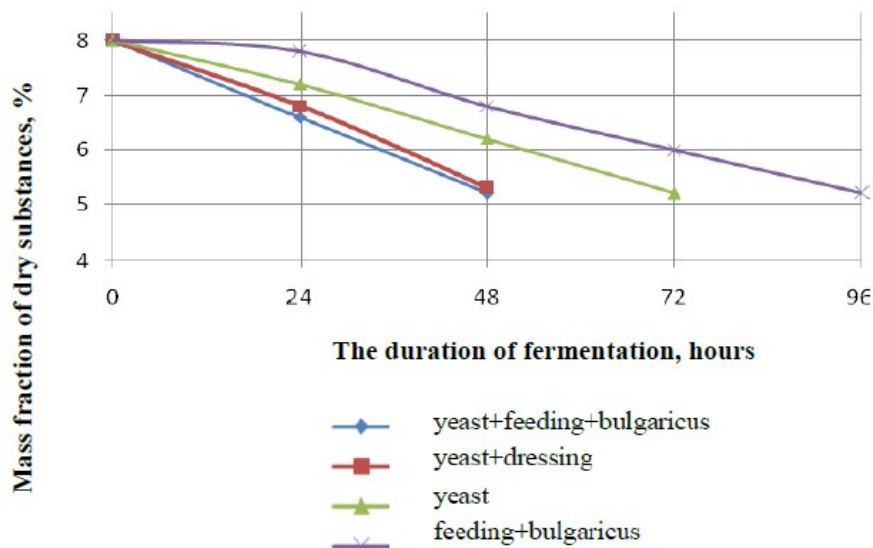


Figure 3 – the Dynamics of the digestion model No 2

This can be explained by the fact that when making nitrogen fertilization environment is enriched with nitrogen, necessary for vital activity of yeast. In the second case, the must is enriched not only with nitrogen but also lactic acid, which is lactic acid bacteria during the fermentation of sugars and also creates favorable conditions for vital activity of yeast.

Physical and chemical indicators of the quality of the resulting beverage are shown in table 4.

**Table 4** – Physico-chemical indicators of quality beverages with adaptogenic properties

Name of the indicator	Sample 1	Sample 2
Mass fraction of dry substances, %	5.2±0.1	5.3±0.1
Mass fraction of alcohol, %, no more	1.05±0.02	0.98±0.02
Mass fraction CO <sub>2</sub> , %, not less than	0.4±0.1	0.4±0.1
Acidity, K. ed.	4.1±0.2	3.7±0.2
The contents of polyphenolic compounds, mg/100 cm <sup>3</sup>	51.2±6.0	29.3±6.0
Mass fraction of vitamin C, mg/100 cm <sup>3</sup>	29.2±1.2	25.4±1.2

## 5. Conclusion

1. Added methodology for the development of functional foods, the design principles of the drinks based on herbal adaptogens.

2. Developed formulation and technology of production of beverages that do not contain synthetic additives. As dyes were natural pigments included in the composition of plants. The parameters of the most rational parameters of digestion.

Vitamin C content in the obtained fermented beverages allows you to provide up to 50 % of the daily requirement of the human body ascorbic acid (daily requirement of 90 mg), with one-time consumption of 250 cm<sup>3</sup> of the drink. In addition, the drinks are a good source of intake of polyphenolic compounds, which represents added value for consumers. Compounds such as leucoanthocyanins, rutin and a number of close connections belong to the P-active and possess biologically active beginning.

Polyphenolic substances, as natural synergists, ascorbic acid, increase the strength of capillaries and reduce their permeability. Anthocyanins are able to prevent or reduce the negative consequences of radiation injuries. Regular supply the human body sufficient amounts of polyphenolic substances can be one of the measures of prevention imperceptible, but continuous exposure to radiation.

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