



# Study of the Thermal Stability of Ginsengbiomass as a Drying Object

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## Abstract

The problem of receiving biologically active medicines of a broad spectrum of activity for the food, pharmaceutical, cosmetic industry is relevant results of a research of heat stability of biomass of a ginseng for the purpose of justification of temperature condition and a way of drying are presented. Influence of duration and temperature of heating on quality indicators of biomass of a ginseng is studied. It is experimentally established that at a temperature of 400C and durations of heating within 15 hours the maintenance of total glycoside fraction in biomass of a ginseng (SGF) decreases up to 50%; at a temperature of 1000C and durations of heating within 8 hours of SGF about 30% decrease. It is revealed that at a temperature of heating up to 40 0C with increase in duration of heating increase in speed of process of a thermal inactivation is observed. It is established that the admissible temperature of heating of biomass of a ginseng is 600C. At sublimation drying the maintenance of SGF in dry biomass of a ginseng is 1,5 - 2 times higher, than at convective and vacuum drying. On the basis of results of a research the conclusion is drawn on that sublimation drying is the most preferable way of drying in comparison with vacuum and convective, allowing to receive a dry product with the highest quality indicators.

**Keywords:** ginseng biomass, total glycoside fraction (TGF), heat stability, heating temperature, inactivation, drying.

## 1 Introduction

Dietary supplements of a phyto genesis are widely used as immunoexcitants, an additional source of food and biologically active agents. The food enriched with dietary supplements increase resistance of an organism to various diseases, almost healthy people can use them as prophylactic.

The medicines received from fabrics of herbs of adaptogens [1, 2] are of special interest. As one of the most effective remedies of natural origin intended for maintenance of health of the person the ginseng real - *Panax ginseng* of S.A. Meyer differing in the unique chemical composition is used. The traditional Chinese medicine claims that medicines of a ginseng prolong life and youth. The first mention of a ginseng is dated the XVI BC - in the book by the Aesculapian of traditional Chinese medicine [3]. Originally roots of this plant were used in food, but over time began to read a ginseng as the means restoring forces. This plant was considered a symbol of divine harmony on the earth, and its root reminding a body of the person began to be used as a magic amulet on good luck, prosperity, longevity and fertility.

Medicines on the basis of a ginseng increase operability of an organism, are adaptogens and possess the psychostimulating action, are used for prevention of various diseases of the central nervous system. The ginseng contains various biologically - the active connections causing them medicinal properties. And interesting of them triterpene glycosides are the most unique. These are the valuable secondary metabolites having high biological activity [4, 5]. In domestic pharmacology the ginseng is included in the State Register of Medicines as the powerful toning, all-strengthening, adaptogenic tool increasing immunity, and organism resilience at stressful situations [6].

Ginseng - an endangered species. The wild ginseng can still be met in mountain broad-leaved and coniferous forests of Primorsky Krai (Russia) and in the northeast of China. Plantation cultivation of a ginseng is unprofitable because of complexity of cultivation of a plant in simulated conditions, to slow increase of biomass of a root therefore the reliable source of raw materials capable to provide pharmaceutical, food production, was the industrial technology of receiving biologically active medicines (BAV) created in Russia method of cultures of the isolated fabrics and cages of plants of a ginseng [7].

Advantages of use of biomass of vegetable fabrics in comparison with use of the wild-growing or grown-up raw materials [8]:

- receiving vegetable raw materials regardless of climatic and geographical conditions of growth;
- reduction of time of receiving raw materials: for the cultures of cages the period of cultivation is 25-75 days, for a ginseng - not less than 5 years;
- receiving raw materials, standard on maintenance of BAV;
- regulation of growth rate and biosynthesis of BAV.

Stages of technological process of production biologically active drugs as follows: receiving and cultivation of biomass of plant cells and fabrics - receiving dry biomass - receiving and control of biologically active medicines.

Drying is the stage of technological process substantially influencing quality of ready medicine power - and material capacity of production [9].

Now various ways are applied to drying of biological objects: spray-type, drying in the boiling and dense layers, sublimation drying [10, 11].

For thermo labile Products to which ginseng biomass belongs by the dehydration method providing high quality of the received dry product with its preservation during it is long time, sublimation drying in a vacuum is. For realization of process and justification

of parameters of drying it is necessary to consider specific properties of material, in particular, its heat stability.

The heat stability defines the maximum permissible modes of thermal treatment provided that duration of experience corresponds to duration of the used drying method.

The purpose of this work was studying of heat stability of biomass of a ginseng, influence of degree and duration of heating quality indicators of biomass of a ginseng - the total glycoside fraction (TGF), justification of temperature conditions of drying.

## 2. Methods

Object of a research was the ginseng biomass received by method of cultivation of culture of cages on solid agar Murasige nutrient medium - Skuga [12] within 28-30 days of cultivation at a temperature of 25-27 °C.

Stern and Proctor [13] method at which static or isothermal heating of the analyzed sample in the soldered capillaries is carried out were applied to determination of heat stability of biomass of a ginseng.

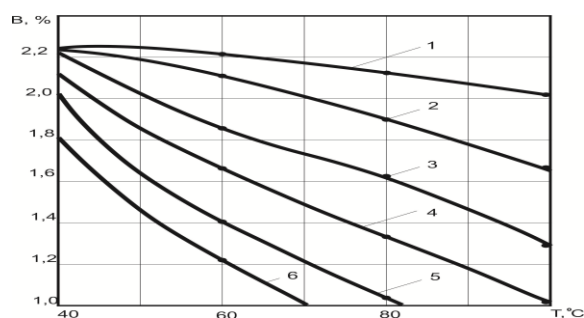
The hinge plate of biomass of a ginseng weighing 3 g was placed in the special tight cartridges manufactured of aluminum foil. Such amount of biomass was sufficient for carrying out further researches of the analyzed product. Biomass layer thickness in the cartridge was in limits of 1,3 - 1,5 mm. Cartridges established in special holders and lowered in the thermostat in which the set temperature was maintained. Control of temperature was exercised by the laboratory thermometer with the price of divisions of 0,1 °C. After keeping in the thermostat of the cartridge cooled and investigated biomass on the maintenance of SGF.

Temperature of the heating environment in the thermostat was changed from 30 °C to 100 °C with an interval of 20 °C. At the set temperature hold time made from 2 to 12 hours. The chosen range of duration of heating corresponded to duration of process of the drying characteristic of the studied methods of dehydration of biological products: convective drying, vacuum dehydration and sublimation. All experiments were made in triple frequency.

## 3. Results and discussion

The thermogram of biomass of a ginseng which analysis visually confirms influence of temperature and a pro-position of heating on the maintenance of the total glycoside fraction (TGF) is provided on the figure 1. So, if warming up at 40 °C within 2-10 hours practically does not reduce biological activity of biomass of a ginseng, then with temperature increase the maintenance of SGF decreases:

- at endurance within 6 hours the maintenance of SGF decreases by 7%;
- at endurance within 15 hours the maintenance of SGF decreases by 50%;
- at temperature increase to 100 the °C in 8 hours the maintenance of SGF decreases to 30%.



**Figure 1:** Dependence of the content of biologically active substances (B, %) on the temperature and duration of heating: 1 -  $\tau = 2$  h; 2 -  $\tau = 4$  h; 3 -  $\tau = 6$  h; 4 -  $\tau = 8$  h; 5 -  $\tau = 10$  h; 6 -  $\tau = 12$  h

For justification of temperature conditions of drying taking into account duration of heating it is necessary to know kinetic parameters of a thermal inactivation of biomass.

The equation of a thermal inactivation can be presented in the form:

$$\ln B = -kT + \ln B_0 \quad \ln B = -kT + \ln B_0, \quad (1)$$

where  $\ln$  - the maintenance of SGF, %;

$k$  - a reaction speed constant, with<sup>-1</sup>.

Influence of temperature on the speed of reaction is similar to kinetics of chemical reactions and is described by Arrhenius's equation [14]:

$$k = Ae^{-Ea/RT} \quad k = Ae^{-Ea/RT}, \quad (2)$$

where  $A$  - the preexponential multiplier characterizing a condition of substance and degree of susceptibility to thermal influence with<sup>-1</sup>;

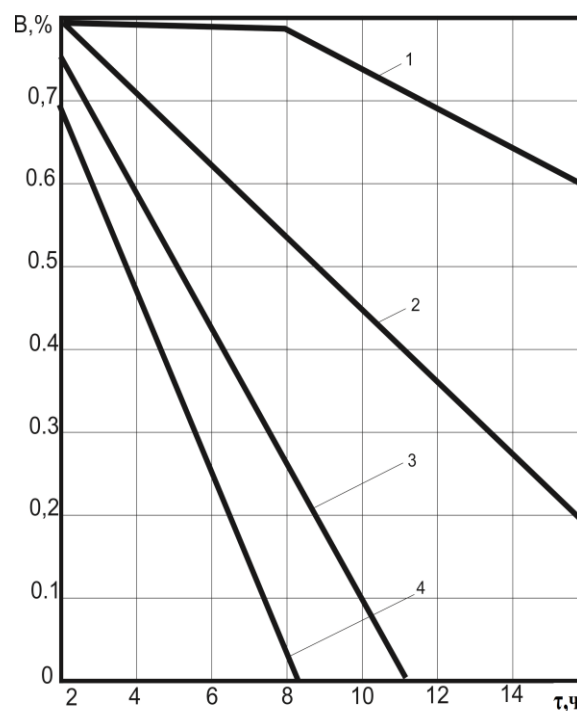
$Ea$  - energy of an inactivation, kJ/mol.

Substituting the equation (2) in the equation (1), we will receive the kinetic equation of a thermal inactivation:

$$\ln B = \ln B_0 - A\tau e^{-Ea/RT} \quad \ln B = \ln B_0 - A\tau e^{-Ea/RT}, \quad (3)$$

where  $\tau$  - heating duration, h.

Kinetic curves of a thermal inactivation of biomass of a ginseng are given in the figure 2. The comparative analysis of curves demonstrates that the speed of process of a thermal inactivation depending on duration of heating is various. With increase in duration of heating the order of reaction remains, however at  $T = 40$  °C with increase in duration of heating increase in speed of reaction is observed.



**Figure 2:** Kinetics of thermal inactivation of ginseng biomass: 1 -  $T = 40$  °C; 2 -  $T = 60$  °C; 3 -  $T = 80$  °C; 4 -  $T = 100$  °C

In the figure 3 the dependence of a constant of speed of an inactivation on temperature which linear interpretation is presented in  $\ln k$  coordinates = to  $f(t)$  is presented. The inflection

point of a straight line, the corresponding 85 °C, characterizes the most admissible temperature of heating of material. However more strict justification of the choice of a method and mode of drying taking into account obtaining desirable quality of the final product can be made only in the careful analysis of such heat technical parameters of process of drying as duration and speed of heating and cooling of material, speed of removal of moisture, hygroscopic characteristics. At the recommendation of any method of drying it is necessary to set the temperature condition of process based on maximum permissible from the point of view of heat stability of material, temperature of the heating environment.

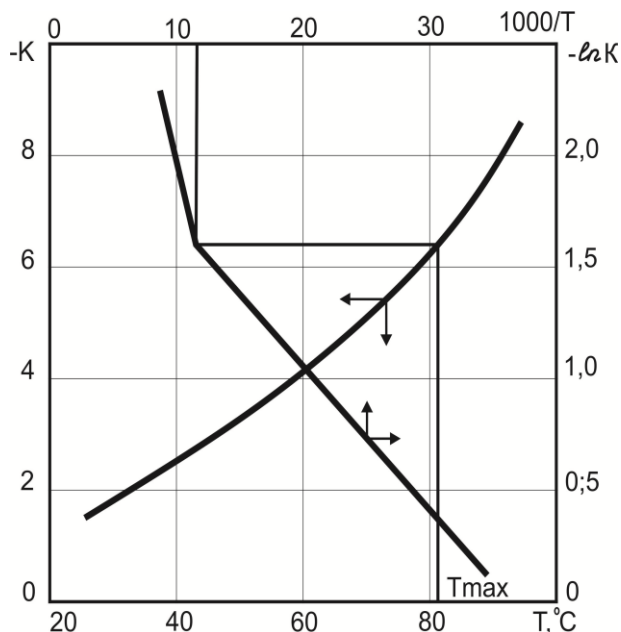


Figure 3: Dependence of the thermal inactivation rate constant on temperature

The most admissible temperature of heating of material at various duration of process is the major technological criterion when developing technology of dehydration of microbiological

materials. Increase in duration of heating reduces the most admissible temperature allowing receiving a quality product. In the figure 4 the dependence of the most admissible temperature on heating duration is presented. Apparently from the schedule, in 4 hours the most admissible temperature of heating of material in the course of drying decreases to 60 °C and with increase in duration of heating practically does not change.

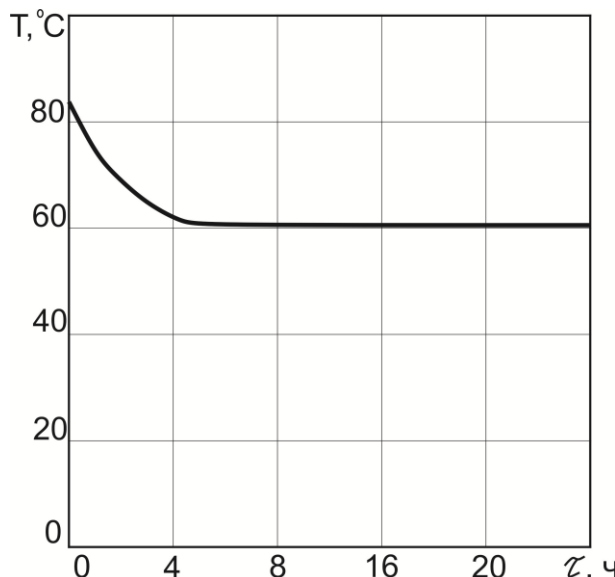


Figure 4: Dependence of the maximum permissible temperature of heating of ginseng biomass on the duration of heating

Therefore, for ginseng biomass drying the most admissible temperature of heating is +60 °C. For justification of a way of drying quality indicators of the biomass of a ginseng which is dried up in various ways were investigated: sublimation, vacuum, convective (atmospheric) at the maximum temperature of heating +60 °C (table 1).

Table 1: Effect of drying methods on the quality of dried ginseng biomass

Indicators	Method of drying		
	Freez-drying	Vacuum drying	Convective (atmospheric) drying
The drying time, h	8	7	4
Mass fraction of solids, however, %	97	95	92
Mass fraction of total glycoside fraction (GFS), %	2,3	1,7	1,5
Colour	Light yellow	Yellow to brown	From light-brown to brown
Solubility	Good, practically free of sediment	Difficult, with a lot of sediment	

Apparently from the table, at sublimation drying of biomass of a ginseng the maintenance of SGF is 1,5 - 2 times higher, than at convective and vacuum drying and also the solubility of dry biomass improves that increases extractive ability of biomass.

#### 4. Summary

1. It is experimentally established that at a temperature of 40 °C and durations of heating within 15 hours the maintenance of total glycoside fraction in biomass of a ginseng (SGF) decreases up to 50%; at a temperature of 100 °C and durations of heating within 8 hours of SGF about 30% decrease.
2. It is experimentally defined that at a temperature of heating up to 40 °C with increase in duration of heating increase in speed of

3. It is revealed that the admissible temperature of heating of biomass of a ginseng is 60 °C.
4. It is established that at sublimation drying the maintenance of SGF in dry biomass of a ginseng is 1,5 - 2 times higher, than at convective and vacuum drying.

#### 5. Conclusions

The conducted researches of heat stability of biomass of a ginseng allowed establishing the admissible temperature of heating +60 °C. Such temperature condition allows use of different ways of drying, however sublimation drying is the most preferable way in comparison with the vacuum and convective drying allowing receiving a dry product with the highest quality indicators.

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