*Available online www.jocpr.com*

**Journal of Chemical and Pharmaceutical Research, 2014, 6(2):765-771**

**Research Article**

**ISSN : 0975-7384**
**CODEN(USA) : JCPRC5**

# Technological characteristics research of aerial parts of yellow bedstraw

**Andriy V. Proskochilo, Victor G. Demianenko, Dmytro V. Demianenko and Svitlana V. Breusova**

*Department of Commodity Science, National University of Pharmacy, Kharkiv, Ukraine*

---

**ABSTRACT**

*The research of technological characteristics of yellow bedstraw materials has been conducted. The main technological parameters of the plant product have been determined and their interconnection with different technological processes has been established. The obtained results have been used to develop the hardware design technology of herbal medicine produced from the aerial parts of yellow bedstraw.*

**Keywords:** yellow bedstraw (*Galium verum L.*), technological characteristics, fractional composition, bulk density, flowability.

---

## INTRODUCTION

Modern development of pharmaceutical science contributed to introduction of many drug products into the Ukrainian market, but only few of them are of plant origin [1]. From the point of view of consumers, as well as many scientists, herbal remedies are in great demand due to its advantages over synthetic drugs [2, 3]. Considering the provisions [4], the development of new drugs should be conducted on a high level.

It is commonly known, that modern medicinal products should be developed in accordance with applicable regulatory documentation [1], but the creation of herbal medications has its own peculiarities. First of all, the plant material that is a source of biologically active substances (BAS) serves at the same time as one of the reasons of microbial contamination of the finished products. Another important aspect of the phytochemical production is the quality indicators of raw material that greatly affect the economic efficiency of technology of the final product output.

With the development of pharmaceutical science, many scientific papers devoted to finding promising sources of receiving BAS with predetermined pharmacological activity and minimal contraindications. The phytocomplexes excretion technologies, as well as individual compounds, become more comprehensive.

Production of new herbal medications from domestic raw materials is one of the key directions of the State program of import substitution [5]. Therefore the implement of raw materials complex processing and application of advanced world technologies are priorities to the phytochemical research. These measures will increase the profitability of herbal medications production. One of such technological methods is solvent extraction in sub- and supercritical regimes [6].

Analyzing the importance of new herbal medication developing we stopped at the herb of yellow bedstraw (Galium verum L.), to which during many years it has been devoted many works [7, 8]. However, since the moment when we have received this work to release, we have not been found information about technical characteristic research of areal parts of yellow bedstraw in none available literary source. Also there are no data about the extraction of yellow bedstraw parts liquefied with freons. So the purpose of this work is to study the main technological characteristics of herb of yellow bedstraw raw materials.

## EXPERIMENTAL SECTION

The objects of study were samples of crushed dried herbs of yellow bedstraw of 2007, 2008, 2009, 2010 and 2011 years of collecting, harvested during flowering in Poltava, Sumy and Kharkiv regions. Crushing of the dried materials was made in a blender and in the industrial equipment [9-11].

The fractional composition was determined after the famous method [12].

Determination of weight loss during the drying was made by the gravimetric method according to the SFU, 2.2.32 [13, 14]. The weighted amount was 1 g.

Flowability of crushed samples was studied by the method of SFU, 2.9.16.

Bulk density to the shrinkage $\rho_b$ and after the shrinkage $\rho_{1250}$, the volume of researched objects after the shrinkage $V_{10}$, $V_{500}$, has been determined in accordance with the SFU, 2.9.15 in the weighted amounts of 50 g. The capacity for shrinkage was calculated by the difference $V_{10}$-$V_{500}$.

Hausner's ratio (HR) and Carr's index (CI) of samples were calculated by the formula [15,16]:

$$HR = \frac{\rho_b}{\rho_{1250}},$$

and

$$CI = \left( \frac{\rho_{1250} - \rho_b}{\rho_{1250}} \right) \times 100\%.$$

The apparent density $\rho_0$ has been determined as follows. The exact weight of samples, approximately 5 g was dipped into the flasks with volume of 25 ml. From the dropping glass it has been add hexane or methylene chloride to the mark, then the apparent density $\rho_0$ has been calculated as follows:

$$\rho_0 = \frac{m}{25 - V_s},$$

where: m - exact weight of raw material, g; $V_s$ - volume of poured solvent, ml.

The $P_m$ porosity has been calculated with the divergence of apparent and bulk density:

$$P_m = \frac{\rho_0 - \rho_b}{\rho_0}.$$

The $P_b$ porosity has been calculated after the formula:

$$P_b = \frac{\rho - \rho_0}{\rho},$$

Where: $\rho$ – the true density of plant tissue which is 1,52 g/cm$^3$ [17].

## RESULTS AND DISCUSSION

The experimental data of fractional composition determination in raw material according to the collecting years are represented at the figure 1 and in the table 1.

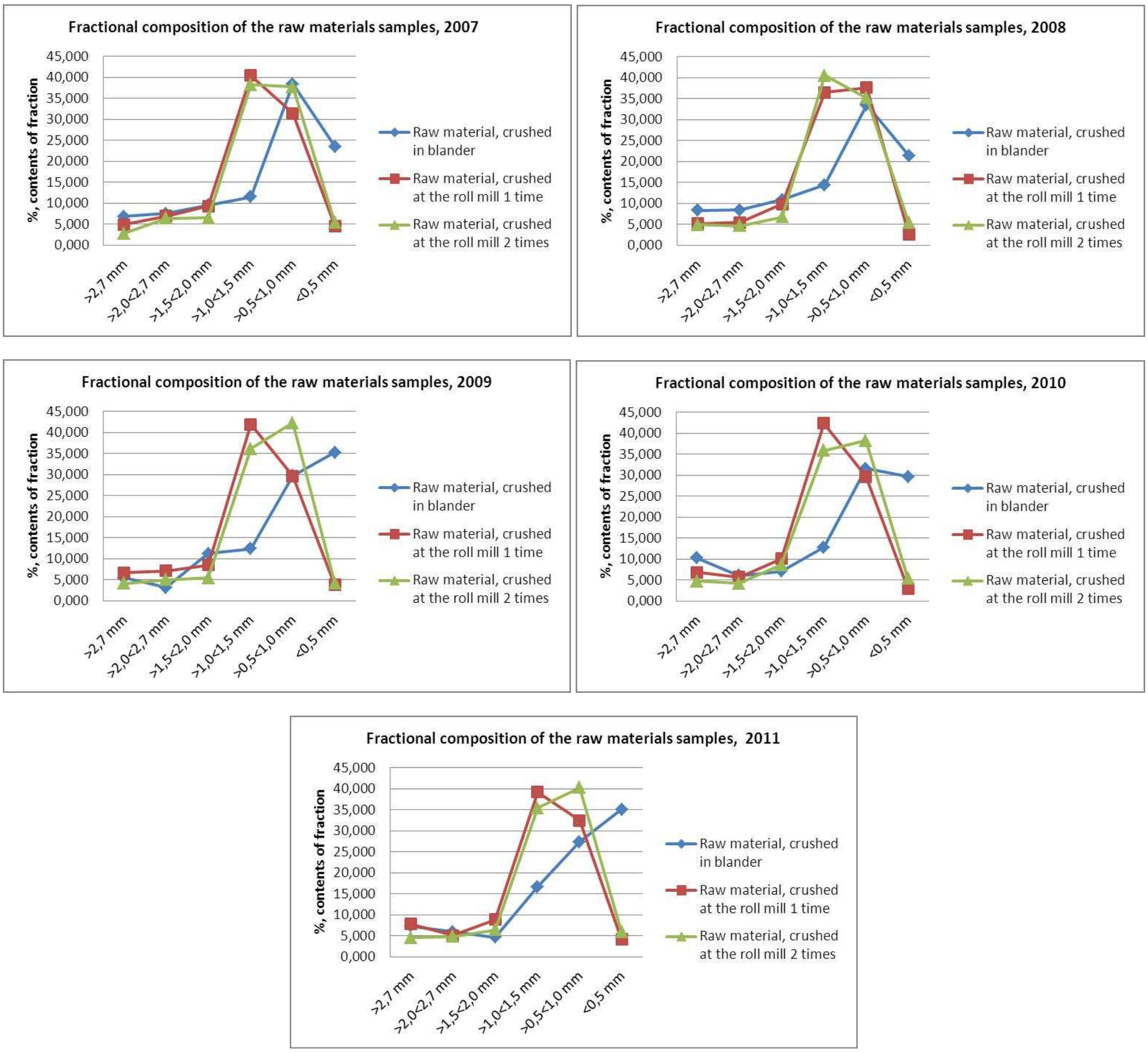


**Fig. 1 Fractional composition of the raw materials samples according to the years**

Fractional composition with the particle size 0,5 - 1,5 mm, % is represented in the table 1.

**Table 1. The results of fractional composition determination with the particle size 0,5 - 1,5 mm of the raw materials samples, crushed with the various methods**

| Collection year | Raw material, crushed in blander, % | Raw material, crushed at the roll mill 1 time, % | Raw material, crushed at the roll mill 2 times, % |
|---|---|---|---|
| 2007 | 49,950 | 71,881 | 77,956 |
| 2008 | 47,990 | 74,159 | 75,754 |
| 2009 | 42,131 | 71,598 | 78,450 |
| 2010 | 44,420 | 72,059 | 74,187 |
| 2011 | 44,044 | 71,687 | 75,694 |

**Table 2 Results of technological characteristic research of the raw material samples, crushed in blander**

| Technological parameter | Raw material crushed in blander | | | | |
|---|---|---|---|---|---|
| | 2007 | 2008 | 2009 | 2010 | 2011 |
| Humidity, % | 6,51±0,32 | 7,27±0,37 | 8,51±0,55 | 7,16±0,72 | 6,96±0,44 |
| Flowability, s/100 g | Absent | Absent | Absent | Absent | Absent |
| Bulk density $\rho_b$, g/cm$^3$ | 0,168±0,0044 | 0,170±0,0058 | 0,174±0,0043 | 0,178±0,0074 | 0,169±0,0031 |
| Volume $V_{10}$, cm$^3$ | 254±0,5 | 258±0,5 | 263±0,5 | 255±0,5 | 260±0,5 |
| Volume $V_{500}$, cm$^3$ | 232±0,5 | 236±0,5 | 240±0,5 | 233±0,5 | 238±0,5 |
| Volume $V_{1250}$, cm$^3$ | 230±0,5 | 234±0,5 | 238±0,5 | 231±0,5 | 235±0,5 |
| Shrinkage ability, cm$^3$ | 22±0,5 | 22±0,5 | 23±0,5 | 22±0,5 | 22±0,5 |

Information about determination of humidity, flowability, bulk density and shrinkage ability of the researched samples of raw materials is represented in the table 2, 3 and 4.

**Table 3 Results of technological characteristic research of the raw material samples, crushed at the roll mill 1 time**

| Technological parameter | Raw material samples, crushed at the roll mill 1 time. | | | | |
|---|---|---|---|---|---|
| | 2007 | 2008 | 2009 | 2010 | 2011 |
| Humidity, % | 7,14±0,62 | 7,85±0,14 | 8,89±0,57 | 8,01±0,34 | 7,63±0,29 |
| Flowability, s/100 g | 132,45*±0,53 | 133,54*±0,27 | 134,24*±0,42 | 125,67*±0,47 | 133,21*±0,29 |
| Bulk density $\rho_{b,}$ g/cm$^3$ | 0,221±0,0036 | 0,224±0,0081 | 0,211±0,0061 | 0,215±0,0058 | 0,222±0,0024 |
| Volume $V_{10,}$ cm$^3$ | 222,5±0,5 | 220±0,5 | 217±0,5 | 219±0,5 | 218±0,5 |
| Volume $V_{500,}$ cm$^3$ | 185±0,5 | 182±0,5 | 179±0,5 | 180±0,5 | 180±0,5 |
| Volume $V_{1250,}$ cm$^3$ | 176±0,5 | 177±0,5 | 173±0,5 | 174±0,5 | 173±0,5 |
| Shrinkage ability, cm$^3$ | 37,5±0,5 | 38±0,5 | 38±0,5 | 39±0,5 | 38±0,5 |

** - only with the powered on vibration motor*

**Table 4 Results of technological characteristic research of the raw material samples, crushed at the roll mill 2 times**

| Technological parameter | Raw material samples, crushed at the roll mill 2 times | | | | |
|---|---|---|---|---|---|
| | 2007 | 2008 | 2009 | 2010 | 2011 |
| Humidity, % | 7,33±0,35 | 7,95±0,53 | 9,13±0,25 | 8,11±0,31 | 8,02±0,46 |
| Flowability, s/100 g | 124,99*±0,61 | 124,16*±0,43 | 115,25*±0,21 | 113,90*±0,52 | 104,81*±0,47 |
| Bulk density $\rho_{b,}$ g/cm$^3$ | 0,223±0,0023 | 0,224±0,0043 | 0,224±0,0054 | 0,228±0,0026 | 0,227±0,0039 |
| Volume $V_{10,}$ cm$^3$ | 219,5±0,5 | 221,5±0,5 | 219±0,5 | 222±0,5 | 221±0,5 |
| Volume $V_{500,}$ cm$^3$ | 181,5±0,5 | 182,5±0,5 | 180±0,5 | 182,5±0,5 | 181±0,5 |
| Volume $V_{1250,}$ cm$^3$ | 180±0,5 | 181±0,5 | 178±0,5 | 181±0,5 | 178±0,5 |
| Shrinkage ability, cm$^3$ | 38±0,5 | 39±0,5 | 39±0,5 | 40±0,5 | 40±0,5 |

** - only with the powered on vibration motor*

The results represented at the tables 2-4 and at the Fig. 1 show that the herb of yellow bedstraw, crushed by the methods mentioned above has the various indexes of the technological characteristics. The average content of humidity in raw material, crushed in blander, at the roll 1 time and 2 times were 7,29, 7,90 and 8,11%.

The average bulk density of yellow bedstraw raw materials, crushed at the roll 2 times was higher than the samples crushed at the roll 1 time and in the blander, and was 0,230, 0,220 and 0,174 g/cm$^3$ (table 2 - 4).

The experimental data of apparent density, porosity and pore volume determination of yellow bedstraw raw materials according to the collection years are represented at the Fig. 2, 3 and 4.

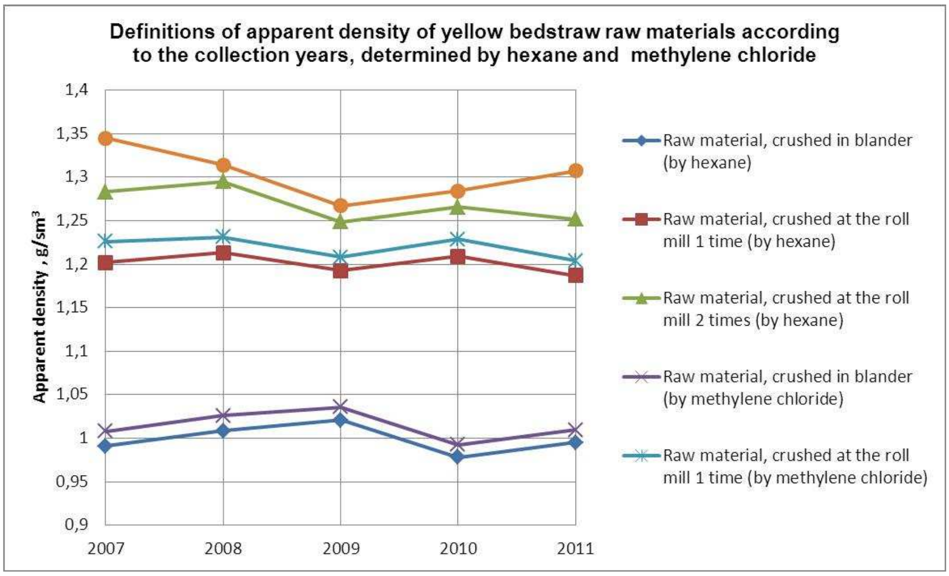


**Fig. 2 Definitions of apparent density of yellow bedstraw raw materials according to the collection years, determined by hexane and methylene chloride**

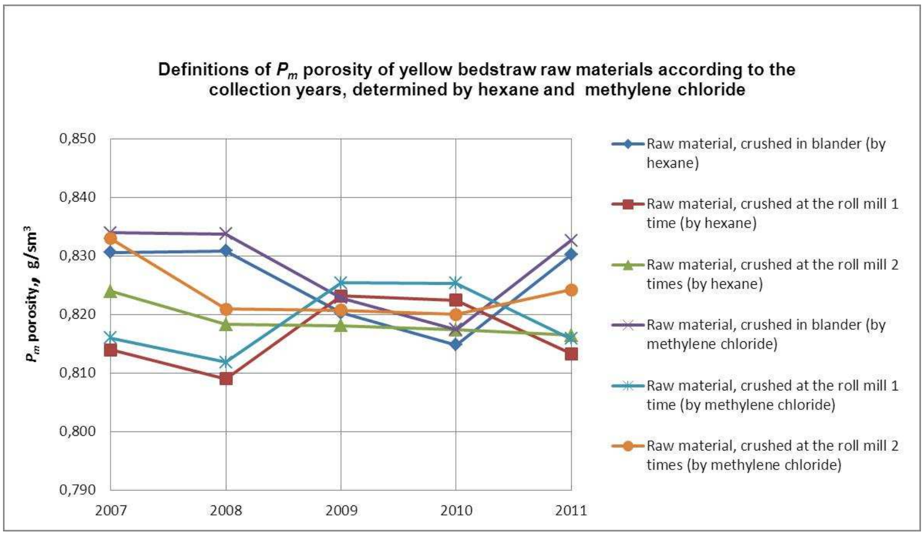


**Fig. 3 Definitions of $P_m$ porosity of yellow bedstraw raw materials according to the collection years, determined by hexane and methylene chloride**

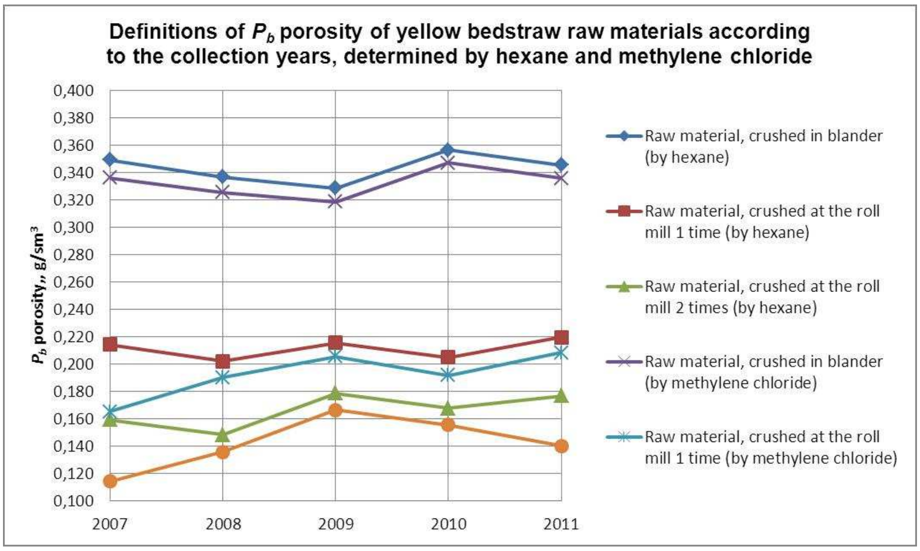


**Fig. 4 Definitions of $P_b$ porosity of yellow bedstraw raw materials according to the collection years, determined by hexane and methylene chloride**

The average values of the porosity of yellow bedstraw raw materials crushed in blander, at the roll mill 1 time and 2 times were 0,825, 0,816 and 0,819. The porosity depends from the number of factors, including the distribution over the sizes and the forms of particles and also over the characteristics of pycnometric liquid and the measurement method [18]. For example the researches [19] examined the positive relationship between the average value of particles and between the porosity.

The differences in the technological characteristics between the raw material samples, which have been examined in this research first of all depend from the fractional content with the particles volume of 0,5 -1,5 mm, and also from the original calculation of the apparent density, porosity and pore volume.

We should pay attention to a such technological factor as flowability. The importance of fluidity for the plant material allows to estimate it flow ability in the vertical direction during the technological operations [17]. The fluidity estimation in the technology of the medical remedies can be made by the different ways. Besides the definition of the friction slope corners by the static or dynamic way using the various hardware and software there is the calculation method trough the Hausner's ratio and Carr's index [20, 21].

Nowadays HR and CI method is widely used for the flowability characteristic of the crushed raw materials in the many technological operations [22-26]. HR <1,25 indicates on the loose powder, while as > 1,25 confirms the bad flowability.

The lower CI the better the fluidity characteristics. For example the index 5-15 shows the excellent, 12-16 shows the good, 18-21 shows the satisfactory and > 23 the bad flowability. The results of HR and CI calculation of the raw materials samples crushed by the various ways are represented at the table 5.

HR and CI can be used for the flowability forecasting. However HR and CI are criticized sometimes, in spite of the fact that their relations with fluidity are empirically received and as the such which have not the theoretical grounds. Nowadays the using of factors is continuing because the equipment necessary for the analysis performance is rather cheap and the technics is simple in employment.

**Table 5 The calculation results of the Hausner's ratio and Carr's index of the raw material samples crushed by the various methods**

| Collection year | Raw material crushed in blander | | Raw material samples, crushed at the roll mill 1 time | | Raw material samples, crushed at the roll mill 2 times | |
|---|---|---|---|---|---|---|
| | HR | CI | HR | CI | HR | CI |
| 2007 | 1,304 | 23,333 | 1,304 | 23,305 | 1,262 | 20,746 |
| 2008 | 1,254 | 20,282 | 1,298 | 22,966 | 1,270 | 21,230 |
| 2009 | 1,208 | 17,235 | 1,394 | 28,270 | 1,281 | 21,918 |
| 2010 | 1,225 | 18,345 | 1,351 | 25,969 | 1,254 | 20,250 |
| 2011 | 1,263 | 20,808 | 1,313 | 23,858 | 1,277 | 21,707 |

The flow ability of plant material depends from some factors the principle of which is the form of particles (ideally spherical), the size of particles and also the addition of lubricants or granulation.

On the basis of the data from the table 5, the HR and CI values correspond to the powder with the bad flowability. However for the preparation of the raw material extraction with the liquefied gas the meaning of raw material fluidity has a secondary character in comparison with the factor of the ability shrinkage because the extractor download with the raw material can be made with the help of vacuum or with the extraction cartridge where the raw material is loaded manually using the additional ramming [17, 27]. Besides it is impossible to achieve the spherical form of particles for the plant material which is related with the anatomical characteristic of the last one [28].

Therefore, at the base of the researches it has been determined the main technological characteristics of yellow bedstraw with the aim to find the parameters of the general technological equipment and also the choice of the crushing and preparation method of the raw materials to the extraction process by the liquefied gas. The results of this research have been used for the development of the herbal medicinal products industrial technology at the base of yellow bedstraw.

## CONCLUSION

It has been examined the influence of the fractional composition and the humidity at the bulk density and flowability of yellow bedstraw crushed with the different methods. At the base of the results of our own researches and also the information which we have found in the literature it was established that the factors which have the great influence at the technological parameters of yellow bedstraw is the humidity and the size of particles of the researched materials. Also it has been established that the measurement methods have the influence on the meaning of the technological factors. However the difference in the meaning of some factors is in the unreliable dependence so the use of figures of the technological parameters can influence at the calculation of the material balance of the extraction process and as a result the efficiency reduce at the cost value increase of the herbal medicinal products manufacture.

## REFERENCES

[1] AV Gudzenko; OO Tsurkan; T.V Kovalchuk; *Pharmacology and Drug Toxicology*, **2012**, 5(30), 99-106.
[2] KI Makukh; IA Dudenko; *Clinical pharmacy, pharmacotherapy and medical standardization*, **2009**, 3-4, 190 - 195.
[3] OS Shpychak; *News of Pharmacy*, **2013**, 3(75), 64-68.
[4] Order №769 of MOH of Ukraine 13.09.2010 [Electron. resource]. –
Available from http://www.moz.gov.ua/ua/portal/dn_20100913_769.html
[5] Draft concept of the State Target Program [Electron. resource]. –
Available from http://www.apteka.ua/article/78579
[6] IN Zilfikarov; Новые подходы в разработке и стандартизации фитопрепаратов из эфирномасличного сырья //Автореф. дис. д. фармац. наук: 15.00.02 / И.Н. Зилфикаров; ПГФА. - Пятигорск., **2008**. - 48 с.
[7] YA Starchak; Фармакогностическое изучение растений рода подмаренник // Автореф. дис. канд. фармац. наук: 15.00.02 / Ю.А. Старчак; КурГМУ. - Курск., **2009**. - 19 с.

[8] AL Hemcinschi; Contribuţii la studiul unor specii indigene de Galium şi Ajuga. Rezumat tez ă de doctorat. **2010**, Universitatea de Medicinăş i Farmacie „Gr. T. Popa Iaşi.
[9] AI Osetsky et al.; *Problems of cryobiology*, **2009**, V19, 4, 488-499.
[10] AI Osetsky; EV Stryuchkova; *Kholodilnaya tekhnika i tekhnologiya*, **2008**, 1, 57–62.
[11] SI Kreshchenyuk; VI Litvinenko; AP Prokopenko; *Pharmaceutical Chemistry Journal*, **1971**, V.5, 6, 363-365.
[12] European Pharmacopoea 5.0. Councial of Europe. - Strasbourg, **2005**.
[13] Державна Фармакопея України / Державне підприємство «Науково-експериментальний фармакопейний центр». 1-е вид. – Харків: РІРЕГ, **2001**. – 556 с.
[14] Державна Фармакопея України, Доповнення 1 / Державне підприємство «Науково-експериментальний фармакопейний центр» на підставі Європейської Фармакопеї. – Харків: РІРЕГ, **2004**. – 494 с.
[15] HH Hausner; *International Journal of Powder Metallurgy*, **1967**, 3 , 7–13.
[16] M Gibson, Pharmaceutical Preformulation and Formulation: A Practical Guide from Candidate Drug Selection to Commercial Dosage Form. Boca Raton: CRC Press, **2001**; p. 373.
[17] DV Demianenko et al.; *News of Pharmacy*, **2009**, 3(59), 41-45.
[18] S Kamath; VM Puri; HB Manbeck; R Hogg; *Powder Technology*, **1993**,V.76, 277-289.
[19] Y Zhang et al.; *American Journal of Biochemistry and Biotechnology*, **2012**, 8(2), 44-53.
[20] A Guo; JK Beddow; AF Vetter; *Powder Technology*, **1985**, V.43, 3, 279–284.
[21] F Podczeck & BE Jones. Pharmaceutical Capsules. London, Pharmaceutical Press, **2007**; p. 111.
[22] S Jagdale et al.; *J. Chem. Pharm. Res*., **2010**, 2(2), 330-338.
[23] SB Narkhede et al.; *J. Chem. Pharm. Res*., **2010**, 2(4), 722-726.
[24] D Srinivas et al.; *J. Chem. Pharm. Res*., **2010**, 2(5), 534-540.
[25] T Kumar et al.; *J. Chem. Pharm. Res.*, **2011**, 3(3), 742-749.
[26] CO Agubata et al.; *J. Chem. Pharm. Res*., **2012**, 4(3), 1625-1628.
[27] SV Garna et al.; *Zaporozhye medical journal*, **2011**, 1, 55–57.
[28] SV Garna et al.; *Current issues in pharmacy and medicine: science and practice*, **2012**, 1(8), 54-57.