Seabuckthorn as a source of Serotonin

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Traditionally, the major (staple) product from sea buckthorn is fruits. Much of byproducts such as leaves and branches are put out at harvesting. According to literature data, leaves and branches are a valuable row material for obtaining biologically active substances [1, 2]. Some investigators have found a wide range of unsaturated fatty acids and other compounds, which have anticancer and antioxidant properties, in leaves [3, 4]. Ways of extracting valuable substances from biomass have been studied extensively, but their processing in our country is not yet common practice. Nevertheless, there are ongoing studies of leaves and branches, and interest in this research increases. In our work, we studied the possibility of using sea buckthorn branches for obtaining serotonin. This hormone is an important neurotransmitter in animal and plant organisms; it is involved in transmitting neural impulses [5]. Serotonin level contributes to the psychical and social status of animals and man, and, when the level is critically low, psychical pathologies, including depression, develop [6]. At present, synthetic serotonin adipate is used for treatment of neural pathologies. In nature, a potential source of serotonin is sea buckthorn. According to literature data, this hormone is mostly contained in the sea buckthorn cortex [7]. The content of serotonin in different parts of the sea buckthorn plant and its dynamic in the shoots were investigated in our work. An original way of obtaining serotonin from sea buckthorn developed in ISSCM SB RAS was shown. A possibility of the industrial harvesting of sea buckthorn shoots as a serotonin raw material has been considered.

The sea buckthorn collection of ICG SB RAS and wild forms were used in work. The hormone level was determined in a laboratory of ISSCM. Mechanic-chemical activation of plant material allows the serotonin output to be increased due to destruction of cell walls, fragmentation to atom-size particles, formation of soluble salts and biologically active substances. Products of mechanic-chemical treatment increase the output of active substances during extraction [8]. In the case of serotonin, it is possible to conduct exhaustive water extraction after mechanic-chemical activation. A quantitative analysis of serotonin content in the extract was performed using high performance liquid chromatography (HPLC) on a Milichrom A-02 chromatographer. The standard used was serotonin obtained from “Sigma Aldrich”.

First of all, the test of hormone content in different parts of the plant was made, the time of taking measurements was 2011, autumn. It was found that the highest serotonin content is in the cortex - up to 3.6% and one-year shoots - up to 2.9%, the berries and leaves do not practically contain serotonin - 0.02% and less (Table 1). These results are consistent with literature data [9].

Table 1. Serotonin content in different parts of seabuckthorn row material.

Row material	***Content of serotonin, % of dry mass***
Dry berries	0.005
Pulp	0.001
Leaves (Novosibirsk)	0.02
Leaves (China)	0.36
Branches (Novosibirsk)	0.8-1.6

Branches (China)	3.4
Branches (the Altai)	1.2-2.4
Core of branches	0.2-0.4
Cortex	1.2-3.6%

Nevertheless, samples from China (Qinghai-Tibetan Plateau) can especially be noticed. Serotonin content reaches 3.4% in branches and 0.36% in leaves. This was probably caused by hard growing conditions (high altitude, low rainfall, sudden changes in temperature). This is consistent with data published by Suo Yourui, who determined serotonin in sea buckthorn from Qinghai-Tibetan Plateau [10]. As for sea buckthorn shoots, young one-year shoots have enough hormone for extraction and identification (up to 2-3%) (Table 2).

Obtaining the serotonin row material has some problems. Peeling up the cortex (with the highest serotonin content) is not possible for industrial harvesting. This process requires much labor and time and destroys adult plants. For industrial processing, it would only be possible if sea buckthorn plantations were to be eliminated. Thus the most suitable row material is hardwood one-and two-year shoots. It is possible to establish special plantations for producing biomass and to adjust the industrial harvesting of shoots.

The goal of our experiments was to find the most acceptable period for harvesting shoots. The rates of accumulation of the hormone during the vegetation season were investigated for this purpose.

Table 2. Serotonin content in sea buckthorn shoots depending on age (different cultivars, October-January, 2012).

Age of shoots	***Serotonin content***
One-year branches (without leaves)	2.15-3.16
Two-year branches (without leaves)	2.04-2.11
Dry branches	0.24-0.50

Table 3. Dynamics of serotonin content in sea buckthorn shoots during the year.

Cultivar	***Harvesting dates***											
	20.04	***24.05.***	***23.06.***	***21.07.***	***18.08***	***30.08***	***03.09***	***15.09***	***21.10***	***25.10***	***25.01***	***22.03***
Zyrianka	1.45	0.89	0.60	0.39	-	0.75	-	-	-	0.94	2.69	2.22
Zarnitsa	1.57	1.08	0.57	0.45	-	-	-	1.10	-	0.91	1.83	2.21
Krasny Fakel	1.33	0.82	0.47	0.30	-	-	-	1.05	-	1.37	1.68	2.08
Siberian Rumyanets	1.76	1.04	0.40	0.22	0.75	-	-	-	-	1.61	2.24	2.27
Wild form	1.58	1.22	0.69	0.17	-	-	0.86	-	2.18	-	-	2.92

As can be seen from Table 3, the level of serotonin was decreased during April-July, which was caused by the opening and growth of leaves; they do not practically contain serotonin. Thus the highest hormone level was observed early in the spring (before leaves open) and late in the autumn

(after leaf fall). This index in this time reached 1-2.9% of dry weight and differed across varieties and forms. These periods are the most technological for harvesting the raw material.

Conclusions: Sea buckthorn represents a raw material for a valuable substance, the hormone serotonin. It was discovered that the most acceptable row material for extracting serotonin is young one-year shoots and the most suitable time for harvesting is from October to March. Differences between sea buckthorn varieties and forms have been identified. A method of mechanical and chemical treatment of the row material, identification and determination of serotonin content in sea buckthorn has been developed.

Literature

1. Salenko V. L., Kukina T. P., Karamyshev V. N., et al. Chemical study of *Hippophae rhamnoides*. Main components of the neutral fraction of saponification products of extracts from sea buckthorn leaves. Chemistry of natural Compounds. 1985, V 21, P. 481-485.

2. Lu Rongsen. The flavonoid contents in the berries and leaves of Hippophae. Abstract Proceedings of the 5-th International Seabuckthorn Association Conference, China, Xining, 2011, P 59.

3. Tang J. Effects of sea buckthorn leaf on the hepatocarcinogenesis of aflatoxin B. In Proceedings of the International Symposium on seabuckthorn, Xian, China, 1989, P 384-386.

4. Grey C., Widen C., Adlercreutz P, Rumpunen K., Duan R-D. Antiproliferative effects of sea buckthorn (*Hippophae rhamnoides* L.) extracts on human colon and liver cancer cell lines. Food Chemistry, 2010, V. 20, P 1004-1010.

5. Miller-Butterworth C.M., Kaplan J.R., Barmada M.M., Manuck S.B., Ferrel R.E. The serotonin transporter: sequence variation in *macaca fascicularis* and its Relationship to dominance. Behavior Genetics, 2007, V.37, P. 678-696

6. Turner J.H. Handbook of Social theory / Springer, 2000, 745 p.

7. Koshelev Y.A., Ageeva L.D. Seabuckthorn. Biysk, 2004, P. 269-272

8. Snapolov E.G., Lomovsky O.I., Silicon dioxide-flavonoid composites synthesized by mechanochemical method. Journal of International Scientific Publication, 2013, V. 7, part 3 P 39-48

9. Brad I., Vlasceanu G.A., Brad I.L., Manea S.T. Characterization of sea buckthorn fruits and copses in term of serotonin and microelements. Innovative Romanian Food Biotechnology, 2007, vol. 1, p. 23-30.

10. Li Mao, Suo Yourui. Detection of 5-hydroxytryptamine hydrochloride of *Hippophae rhamnoides* L. from Qinghai-Tibetan Plateau. Abstract Proceedings of the 5-th International Seabuckthorn Association Conference, China, Xining, 2011, p. 69.