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The ways of industrial food fortification with vitamins

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Abstract. Currently, the problem of industrial food fortification with vitamins and micronutrients has become far more acute. The lack of vitamins and in particular vitamin C affects every organ system in the body. Food fortification with synthetic nutrients cannot be regarded as a promising solution. Indigenous plants may be used as rich sources of vitamins. One of them is ramson (*Allium victorale*), a plant which is widely known in home cooking. This research involved studying chemical composition of ramson depending on the territory of growth. In order to provide more rational use of the plant special attention was paid to the content and distribution of vitamin C. Studies have revealed that ramson is a source of vitamin C and Ca. Based on the results, waste-free technology of ramson processing with subsequent production of a vitaminized product has been developed. Dried and frozen ramson leaves and ramson paste are semi-processed foods thus obtained. Guidelines on food fortification on the basis of these semi-processed foods have been developed. Loss and waste amounts which occur along hydromechanical processing of ramson are determined. The experiments estimated that, on average, the amount of waste during primary processing of ramson at food companies is about 23 - 28%. The study also involved calculation of nutritional value for semi-processed ramson foods. Variations in the vitamin C content during storage of the developed semi-processed ramson foods were also examined. Based on the results, the most promising way of ramson preservation is determined. This is production of a semi –processed food "Ramson paste". Sanitary indicators of the developed semi-processed ramson food were studied.

1. Introduction

Currently, the problem of industrial food fortification with vitamins and micronutrients has become far more acute. The lack of vitamins and in particular vitamin C affects every organ system in the body. Food fortification with synthetic nutrients cannot be regarded as a promising solution. Indigenous plants may be used as rich sources of vitamins.

One of them is ramson (*Allium ursinum* L.), a plant which is widely known in home cooking and is a good source of vitamins. Utilization of fresh ramson is quite difficult due to its peculiar taste and odor. At the same time, it can be used as an additive to solve the problem of food fortification with vitamins.

Bear leek or bear's garlic (*Allium victorale*) is a medicinal and dietary plant species growing in moist woodlands in mountainous regions of Ural, Siberia, Altai, Sakhalin, Kamchatka, Caucasus, Mongolia, Japan, North America, China and many European countries. This plant has long been known and used as an excellent antiscorbutic agent [1 -11]. Therefore, necessity to study chemical composition of ramson and develop various ramson based foods is obvious.

The aim of this study is to find the way of industrial food fortification with vitamins by developing a resource-saving technology to produce semi-processed ramson food of high nutritional value.



In support of the research aim, the following objectives were set:

- Studying chemical composition of ramson depending on the territory of growth.
- Developing waste-free technology of ramson processing with subsequent production of a vitaminized product.
- Developing guidelines on food fortification with vitamins on the basis of the obtained semi-processed foods.
- Calculating loss and waste amounts which occur along hydromechanical ramson processing.
- Calculating nutritional value for semi-processed ramson foods.
- Studying variations in the vitamin C content during storage of the developed semi-processed ramson foods.
- Studying sanitary indicators of the developed semi-processed ramson food.

2. Materials and methods of research

The object of the research is leaves and stems of ramson growing in the vicinity of the city of Krasnoyarsk, Krychkovo and Chernorechenskaya stations and semi-processed food obtained from them - dried and frozen ramson and ramson paste. The studies were carried out using standard methods.

3. Results

This research involved studying chemical composition of ramson depending on the territory of growth. In order to provide more rational use of the plant special attention was paid to the content and distribution of vitamin C. Studies have revealed that ramson leaves contain on average twice as much vitamin C as stems. At the same time, when comparing the chemical composition of plants growing in the vicinity of Krasnoyarsk, Chernorechenskaya and Krychkovo stations, there is a tendency to increase the amount of vitamin C by 5-7% if they spread to the North (figure 1).

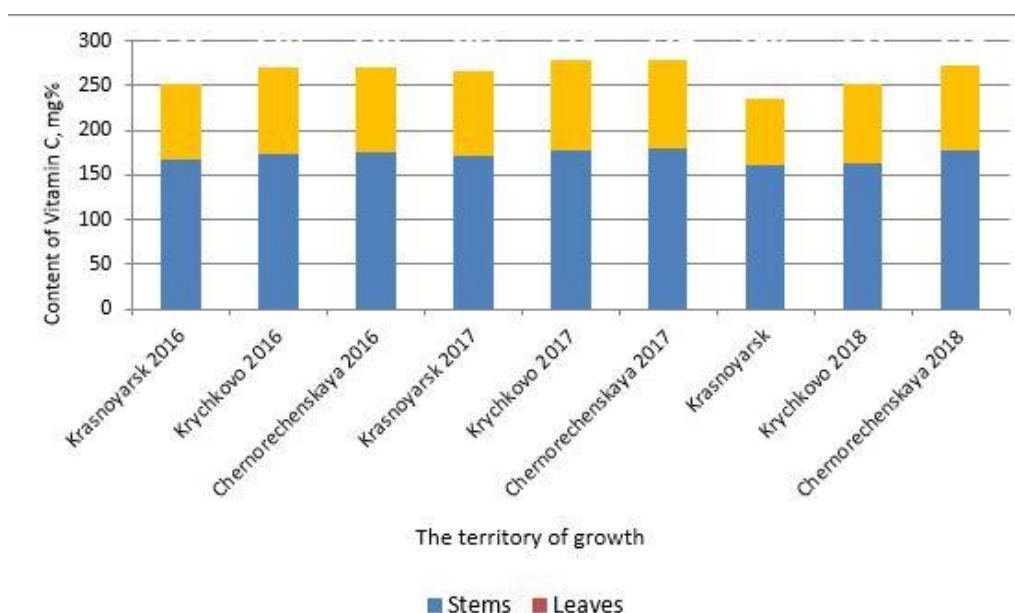


Figure 1. Comparative study of vitamin C content in ramson stems and leaves depending on the territory of growth, 2016-2018.

Thus, the use of ramson leaves or leaves and stems to produce vitaminized paste can be considered the most expedient. This would allow to solve the problem of waste-free technology for ramson processing with subsequent production of a vitaminized product.

It is proposed to develop a ramson paste, which can be further used to prepare cold and hot snacks, cold and hot dishes, flour-based food. The process flow diagram of ramson paste production is shown in figure 2.

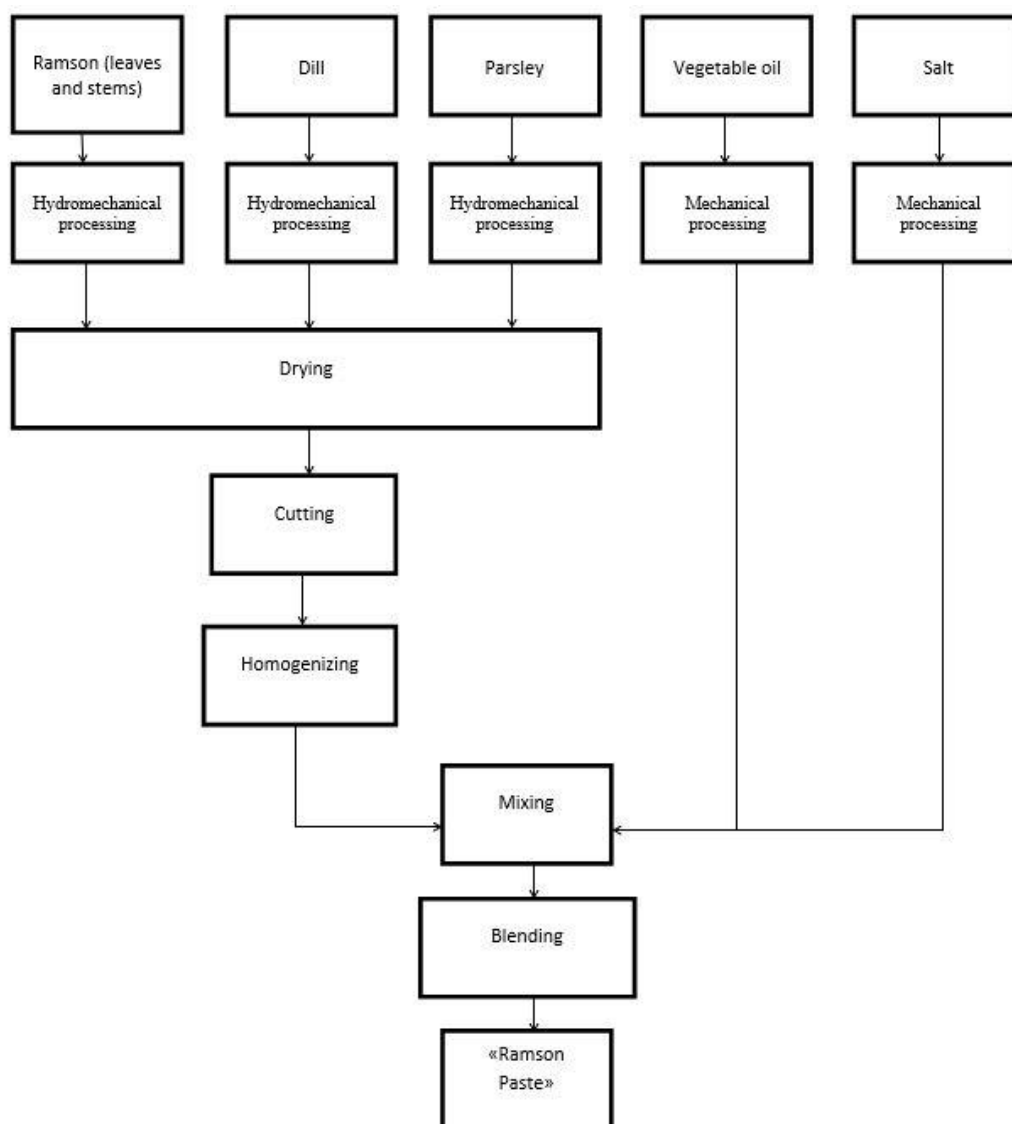


Figure 2. The process flow diagram of ramson paste production.

Organoleptic properties of ready-to-use ramson paste are determined (table 1).

Table 1. Organoleptic properties of ready-to-use ramson paste.

Organoleptic properties	Characteristic
Appearance	pureed mass, smooth and homogenous in texture

Color	with fine particles of herbs dark - green
Taste	pleasant salty taste of fresh herbs with a distinctively rich aroma of fresh ramson
Odor	distinctively rich aroma of fresh ramson and herbs without foreign odors
Texture	smooth and homogenous texture without large particles

The research involved experimental calculation of loss and waste amounts which occur along hydromechanical processing of ramson. The results are presented in table 2.

Table 2. Loss and waste amounts occurring along hydromechanical processing of ramson.

Experiment No	Gross weight , kg	Loss and Waste, kg	Loss and Waste, %	Net weight (processed ramson), kg
1	0,39	0,09	23	0,3
2	0,40	0,1	25	0,3
3	0,41	0,11	27	0,3
4	0,41	0,11	27	0,3
5	0,42	0,12	28	0,3
6	0,42	0,12	28	0,3
Average value	0,405	0,105	26,3	0,3

The experiments have shown that, on average, the amount of waste during primary processing of ramson at food companies is about 23 - 28%.

Chemical composition of the semi-processed food "Ramson Paste":

- 100 grams of ready-to-use ramson paste contain 167 mg of vitamin C, which is 185% of the daily adult requirement.
- 100 grams of ready-to-use ramson paste contain 325 mg of Ca. That 's 32% of the daily intake.

Nutritional value of ramson depending on the storage and preservation condition was determined in the course of the research. On its basis we could choose the most promising method for ramson preservation and subsequent storage.

There are three ways to preserve ramson during the mass harvesting season:

- drying of ramson leaves
- freezing of ramson leaves and stems
- production of semi-processed food "Ramson paste."

Variations in the vitamin C content during storage of the developed paste, dried and frozen leaves and stems were examined in the course of this research in 2017-2018. The results are presented in figure 3.

The research results showed that during storage vitamin C content was the highest in frozen plants. But being thawed and defrosted plants (by the end of the 7 th months) lost their appearance, which resulted in the quality of food prepared using this kind of ramson.

Dried ramson was characterized by the lowest vitamin C content: the content of vitamin C was stable throughout the storage time, but this kind of ramson is of limited use. It can be used as a dry seasoning only.

We consider paste to be the most promising way of ramson preservation.

Paste can be used to prepare cold food and snacks, first and second dishes, various sauces, fillings for flour- based foods.

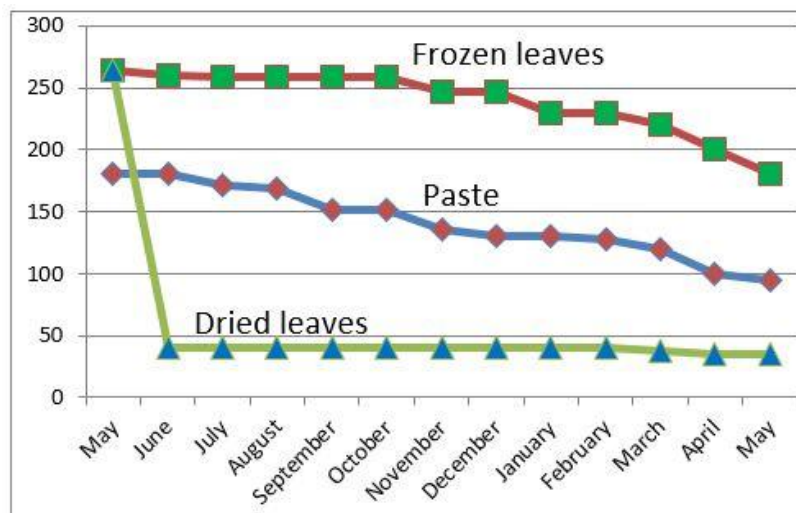


Figure 3. Variations in the vitamin C content during storage of the developed paste, dried and frozen leaves and stems in 2017-2018.

Microbiological parameters for fresh, dried, frozen ramson and ramson paste during storage were studied. The products were stored for 60 days. The growth of microorganisms was detected during storage but the level does not exceed the maximum permissible one. The prospects of using this type of preservation have been proved in sanitary and microbiological studies. The results are shown in table 3.

Table 3. Sanitary indicators for ramson paste, dried and frozen ramson leaves.

Storage period	The method of preservation	Total microbial count per gram	Micro-organism and molds
15 days	Fresh	0,22±0,0510 ³	0,1 ±0,03x10 ³
	Dried	023±0,01x10 ³	0,06±0,002x10 ³
	Paste	0,25±0,04x10 ³	0,3±0,02x10 ³
	Frozen	0,23±0,06x10 ³	0,1 ±0,009x10 ³
30 days	Dried	0,29±0,006x10 ³	0,1 ±0,001x10 ³
	Paste	0,63±0,07x10 ³	0,3±0,08x10 ³
	Frozen	0,29±0,03x10 ³	0,25±0,05x10 ³
45 days	Dried	0,535±0,01x10 ³	0,2±0,003x10 ³
	Paste	2,28±0,2x10 ³	1,09±0,05x10 ³
	Frozen	1,09±0,02x10 ³	0,6±0,09x10 ³
60 days	Dried	0,56±0,02x10 ³	0,4±0,008x10 ³
	Paste	4,37±0,3x10 ³	1,0±0,04x10 ³
	Frozen	2,3±0,4x10 ³	0,9±0,04x10 ³

4. Discussion

The research results show that ramson is a promising source of vitamin C and can be used to produce various semi-processed foods with subsequent production of a vitaminized product. The nutritional value of ramson is described in a number of research works written by the following authors: Ivanova A., Mikhova B., Najdenski H., Tsvetkova I, Kostova I. [1], Godevac D., Vujisic L., Mojovic M., Igniatovic A., Spasojevic I., Vajs V. [2], Satyal, P., Craft J.D., Dosoky N.S., Setzer W.N. [3],

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An advantage to the use of a semi-processed "Ramson paste" as an additive in food production is ensuring the solution of the problem of industrial food fortification with vitamins. It will allow obtaining foods with high content of vitamins and minerals.

5. Conclusion

Based on the studies carried out, it can be concluded that ramson and its semi-processed foods (dried and frozen ramson, ramson paste) are promising sources of vitamin C, Ca, and their use as an additive to food products will allow obtaining foods with an appropriate content of C and Ca.

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