

PROSPECTS OF HAWTHORN INTRODUCTION INTO INDUSTRIAL FRUIT CULTURE

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High-yielding and large-fruited sort of hawthorn “Timiryazevets” differing from basic form with high content of rich, sweet-sour, savoury flesh was created in Russian State Agrarian University-Moscow Agrarian Academy named after K.A. Timiryazev. Besides, hawthorn berries during ripening lose their holding power with branches that allows to completely mechanize the most labour-intensive process of its gathering with a help of fruit harvesters. All this enables to introduce hawthorn into industrial culture considering its value as an important curative and nutritive breed. Research of hawthorn economic-biological peculiarities (winter hardiness, persistence to blasts, diseases, drought resistance, along with high productivity) afforded to draw rather sound conclusion about use prospects of hawthorn sort “Timiryazevets” in a quality of new fruit culture not only for amateur gardeners, but also for large-scale industrial plantings creation.

Key words: hawthorn, trees, harvest, fruits, biologically active substances, fruit-gathering harvester.

Introduction. Low level of health and medium lifetime of Russian Federation population largely depend on insufficient and mainly unbalanced food consumption. According to nutritionists, the quality of food can lengthen or shorten human life as minimum on 8-10 years. For this reason, scientists-growers raise a question about transformation of our traditional gardening with moderate set of low-vitamin fruit cultures to general health horticulture, allowing constantly ensure human organism with all necessary biologically active substances [1-4]. A large variety of less-common especially in the north regions horticultural species (ashberry, viburnum, bird cherry, shadberry, quince, oleaster, black elder, barbery, mulberry, actinidia, honeyberry, magnolia-vine, chokeberry, sea-buckthorn and others) relates to plants, capable to considerably decrease their deficit and in many instances to have medical effect on some diseases [2-5]. Hawthorn separate types of which have valuable general health and nutritive qualities occupies exceptionally important place among them. In connection with abovementioned, perspective research of hawthorn introduction into industrial fruit culture appears to be **the work objective**. To resolve the object in view, it is necessary to solve the following problems: to conduct investigations of biochemical composition of different haw berry sorts and also analyse possibilities of mechanical harvest work organization.

Description of object, conditions and research methodology

In nature hawthorns represent a tree or a bush up to 5 m in height. Body of a tree is up to 10 cm in diameter with dark gray fractured bark. Young shoots are bare or with rare hair; in the period of growth they are greenish; annual shoots – are purple-brown, shiny; long-term shoots – are grayish. Usually hawthorn has a lot of thorns up to 5 cm. Leaves on the shortcut generative shoots are up to 6 cm in length and up to 5 cm in width; on the vegetative – up to 9 cm in length, usually from the both sides (more seldom only on the lower side) they are pileous, rough from above darkgreen, dim and lighter from below. Leaf blade is obovate or oviform sometimes deeply cut with pointed tip and cuneal smooth-edged basis, with 2-3 laminae sawed pairs of different length and width on the periphery. (pic 1). Blooms are yellow-white with an unpleasant odor up to 1,5 cm in diameter, gathered in multiflorous corymbiform inflorescences. There are 5 sepals; 5 petals; 20 stamens, with purple anthers; pistil with inferior and 3-4 (less frequently five) stiles.



Pic. 1. The hawthorn trees, forms № 3 и № 4

It should be noted, that such qualities of hawthorn plants as ornamental, winter hardiness, relative drought resistance contributed to their wide-spread occurrence and such biological particularities as connivent position of bud on bines, their good reawakening and strong leafiness of aboveground part, made hawthorn to be one of the most important cultures during amenity planting of city areas and small holdings.

Hawthorn is widely cultivated in China, Italy, Turkey, Iran, Spain and other countries in the quality of horticultural plant. On the northwest of China hawthorn occupies up to 40% of garden planting where it appears to be a third fruit culture along with apple and pear tree. Fruit yield of some of its sorts exceeds 5t/ha. Such representatives in Belarus appear to be Holmes hawthorn, Douglas hawthorn, and ornamental hawthorn. In our conditions such sorts as blood-red (*G. sanquinea* Pall.) and pontic (*G. pontica* Koch) and also their hybrids differ with analogous productivity (pic 2).



Pic.2. Hawthorn hybrid forms

On the whole earth and especially in the North America plant communities the hawthorn sort (*Crataegus L.*) is represented by 1000 of types. Latin sort nomination descends from Greek “Kra-taios” – strong, that is apparently connected with its tough wood and extraordinarily firm thorns. This rose family genus (*Rosaceae Juss.*) is one of the richest with sorts. Taking into consideration easiness of its cross-fertilization one can suggest a part of it to be interspecific hybrids.

Majority of hawthorn species differ their small-fruited berries, firm attachment of fruits to bines, flavourless starchy flesh during ripening and etc. that makes them practically unsuitable for use as in fresh so for processing. There also exist sterile forms suitable only for hedge creation. Besides, plants of many species differ with plentiful root stalks formation that also restricts possibility of their using in culture.

Research results of haw berries biochemical composition and their appliance

Biochemical composition of different hawthorn berries sorts slightly varies, but on the whole berries contain 4-11% of sugar (mainly fructose), 0,26-0,93 % of malic acid, 60-180 mg % of triterpene acids, 0,59-0,61 % of pectin, 0,84-1,73% of tan and coloring substances, about 3,4 % of coumarins, including umbelliferones reducing prothrombin index. In addition, up to 250 mg % of ascorbic acid, 380-680 mg % of vitamin P, 2-14 mg % of carotene, and in some species up to 5% of vitamin E are discovered in berries. Dried berries are rich with sorbite (up to 22,5%). In Central Asia haw berries in floured condition are added to scones' dough [4, 5, 6].

Berries are gathered in phase of complete ripeness and dried in a stove at temperature up to 70 °C and also at the attic floors, under the leads, in dry weather and in the sun. For long-term usage in a fresh condition, berries are frozen.

As crude drug haw berries – Fructus crataegi and haw blooms Flores crataegi are stored up. Its storage is allowed from the following the most commonly spread sorts in our country: b. blood-red – *C. sanguinea* Pall; b. smoothed – *C. laevigata* (Poir) DC; thorny – *C. oxyacantha* sensu Pojarc; b. Korolkov – *C. Korolcovii* L., Hensy; b. altaic – *C. altaica* (Lond) Lange; b. yellow – *C. chlorocarpa* Lenne et C. Koch; b. daurian – *C. dahurica* Koehne ex Schneid.; b. monogynous – *C. monogyna* sacd; b. german – *C. alemanniensis* Cin; b. pentagynous – *C. pentagyna* Waldst. Et Kit; b. eastern - baltic – *C. orientobaltica* Cin; b. bent-sepaloid – *C. curvisepala* Lindm; ♂. kurzemskii – *C. curonica* Cin; ♂. *C. dunensis* Cin. and etc. [5]. Majority of its sorts are suitable only for blooms storage because of small-fruited berries and low content of inedible starchy flesh. From large-fruited sorts the greatest attention should be paid to b. blood-red, b. pontic, b. Douglas, b. Holmes, b. ornamental, b. Poyarkova, b. Turnefor, b. greenmeat, b. eastern.

Biochemical composition researches of some hawthorn berries sorts and forms, led in the biochemistry laboratory SSU ARSRI Genetics and breeding of fruit plants named after I.V. Michurin showed that at an average berries accumulate more than 20% (from 18,4 to 31,78%) of dry soluble solids. Sugar content balances from 9,72 to 14,5%, and titrate acids from 0,80 to 1,5%. Ascorbic acid accumulation keeps on the level from 30,8 to 66,0 mg %. Therewith, berries of all sorts differed with high content of polyphenolics (catechins, anthocyanins, flavonols) that allowed using them during development of functional food, helping human organism to maintain vital functions in good condition[5].

Analogous developments were conducted in RSAU-MAA named after K.A. Timiryazev [6]. Nowadays people use medications with haw berries (krategin, krateponin, kardiovalen and others) which take cardioactive effect, normalizing palpitation rhythm; have spasmolytic characteristics, widening coronary vessels and brain vessels; positively influence on venous pressure level and vascular walls condition.

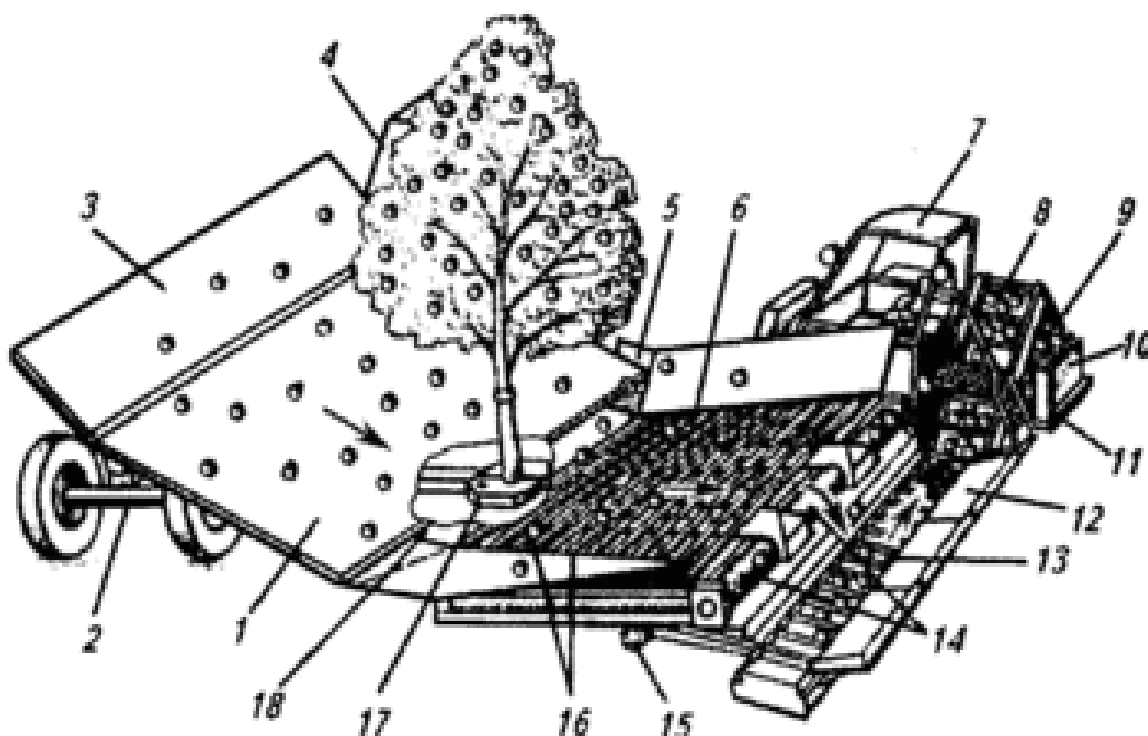
Hawthorn galenic forms have antiarrhythmic activity. Hawthorn medications are taken during rapid hearts, insomnias, hypertension (ABP). As a result of hawthorn taking, patients have general health mend, moderate hypertension reduction, decreasing or subsiding of headache, entotic sound, dizziness, and blood cholesterin content. According to electro-cardiological research, myocardium functional status and coronary circulation improve during coronary disease. Combined taking of hawthorn and valeriana medications properly influences on insomnia and cardiac neurosis.

Hawthorn is widely spread in pharmacological industry of France, Mexico, Rumania and other countries. Bloom and berry extracts are applied in veterinarian practice to improve blood circulation and also as cardioaccelerator in case of atherosclerosis and cardiac neurosis, myocardial insufficiency of animals. Hawthorn is also a good honey plant. Its bark can be used in a quality of hardener and its roots can serve as a basic material for harmless yellow food color obtainment. Hawthorn berries contain significant quantity of sugar, organic acids, pectic materials and can be used as in fresh so in processed form for jam, puree, juice, stewed fruit and etc.

On the base of dry raw berries using of less-common hardy-shrub plants (snowball tree, ash-berry, chokeberry, hawthorn, quince, dogrose and etc.) was created a composition of ingredients for polyvitaminic drink making which is characterized by high gustatory qualities, good general health effect and biologically active substances content: vitamins (C, P, B₁, B₂, K, E, β - carotene and etc.), macro- and microelements, organic acids, volatile oils, glycosides, alkaloids and etc. First of all this polyvitaminic drink is intended for vitamin deficiency prevention of C and P, muscle tone increasing, body defenses amplification, immunity support, blood pressure normalization and etc. Besides, consumption of this vitamin drink has no side on negative effects.

Harvest mechanization of haw berries

Labor contribution analysis of raw materials obtainment for hawthorn production shows that harvesting appears to be the most laborious from all the other agronomical processes of plants handling. A solution of this problem can be presented in two ways, specifically, with a help of fruit harvesters development and sorts creating, differing their feeble attachment of berries to bines [1, 8]. Fruit-gathering two-aggregate harvester KPU-2 is presently used for fruit harvesting from the trees of seed, fruit and nut crops in the gardens with planting width more than 6m and crown vertical projection diameter up to 7m (pic. 3).



Pic. 3. Fruit-gathering two-aggregate harvester KPU-2:

1, 3, 6 – collecting frames; 2, 15 – chasis joist-frame; 4, 7 – right and left aggregates; 5, 12 – sloped surfaces; 8 – conveyor incline part; 9 – linen hill; 10 – container; 11 – platform; 13, 14 – conveyors; 16 – shock-absorbers; 17 – standard vibrator; 18 – consolidator

In the process of harvest right and left aggregates of combine running on neighboring spacings come to a tree in such a way, that marks on the consolidator 18 align with the middle bole, after that collecting frames from the both sides are pulled out up to their closing. Then a vibrator is

switched on. In the result of vibrations fruits come off and fall on collecting frames and absorbing ribbons 16, roll down on cross transfers, which deliver berries to traveling bed 13, and then to dividing linen hill 9. Ribbon of the hill moving towards berries flow catches leaves and other rough admixtures, carries them up and throws under the machine and roundish berries roll down the tare.

Combine production is 35-45 trees per hour, fruit harvest entirety is 91...95 %, aggregates are served by 2 tractor operators and 2 workers. Fruit harvesters also can be used with analogous goal: self-propelled MPU-1 and BUM-15, built up on the base of T-16M; tractor-drawn KBP-1 and others, including fruit harvesters of foreign manufacture [1, 4, 8]. Above mentioned agricultural machineries can also be used for hawthorn fruit harvest. At first it is necessary to conduct investigations of physical and mechanical properties (toughness and durability) of hawthorn different sorts of wood to choose actuating element and following supplying of it with necessary strength and joggle amplitude. At the second, physical and mechanical property researches are necessary for hawthorn berries to provide their harvest and entirety in the course of different ways of mechanical harvest.

Analysis of hawthorn large-fruited forms showed that Pontic hawthorn differs with its less firm berries attachment during their ripening (Table). At this time berries easily fall even under the influence of insignificant wind, giving rise to oscillations of branches. This circumstance served as a base for this sort including into selected process for the purpose of hawthorn high-yielding large-fruited forms obtainment differing with good gustatory qualities of berries and an easy separation from branches in phase of complete ripeness.

Table

Technologic particularities of haw berries in the process of ripeness, 2014

sort, form	Size of berries length. x width., mm	Length of peduncle, mm	average weight of one berry, g	Berry tearing force, g	
				vertical	horizontal
blood-red	1,9 x 1,8	11,2	3,47	141,0	129,3
Pontic form №19	2,2 x 2,0 2,3 x 2,1	5,3 7,8	4,53 4,79	24,3 81,0	5,5 50,1
H CP _{0,5}			0,40		

b. Blood-red has the strongest tearing force and b. Pontic – has the least. Besides, the straight separation required more efforts than side separation that conditioned the best and fuller harvesting under the sharp vibrations of branches.

Conclusions and offers on production

Literary-patent analysis and results of authors proper researches point to high perspective of hawthorn introduction into industrial fruit culture. The results of investigations give ground to consider that harvester KPU-2 and other fruit harvesters appliance allows to completely decide an issue of haw berries harvesting process mechanization. It is necessary to conduct specification of haw berries physical and mechanical properties research within the framework of the following researches to provide their harvest and integrity under the different ways of mechanical harvest. According to preliminary calculations set up of above-mentioned sorts on the area no less than 180 ha is necessary for year-round haw berries production.

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