Economic efficiency of the raw materials production for obtaining a natural food dye from Amaranth

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Abstract. The paper presents the economic results of the raw materials production of the red-violet dye, enriched with antioxidants from the leaves of two varieties of amaranth (Valentina, Don Pedro) breeding of the Federal Scientific Center for Vegetable Growing (Russia). The amaranth plant leaves are used both as a raw material for the production of food-grade natural dye for coloring confectionery products, beverages, and so can be used as part of salads, soups, sauces, enriching them with biologically active substances (in particular, ascorbic acid and phenolic compounds), giving them both original taste and color. The article analyzes the economic efficiency of growing amaranth plants in an open and protected ground, depending on additional mineral fertilizer to obtain a natural food dye. Calculated in prices of 2018, the economic efficiency indicators for both products and resources proved to be satisfactory. Costs per hectare amounted to 77 thousand rubles for cultivation in open ground conditions and 225 thousand rubles for cultivation in a film greenhouse. The cost of raw materials varied from 550 to 880 rubles per kilogram under these conditions. The gross profit ranged from 15 to 125 rubles / ha, profitability ranged from 14 to 81%.

1. Introduction

The emerging consumer market of healthy food products requires creating coloring ingredients that are natural in origin, which is confirmed by the following marketing research results, in particular a share of vegetable dyes in food products is growing [1], [2]. As a rule, dyes of natural origin on the market are obtained from raw food sources, such as carrot, beetroot, etc., the use of which is more appropriate for the intended purpose [3]. In this regard, in recent years, more and more attention is paid to the search for alternative, natural sources of raw materials that are promising both in terms of the content of pigments and in nutritional and biological value, ensuring consumer properties of the products. The variety of red-painted species of amaranth with a high level of accumulation of water-soluble antioxidants allows to use vegetable raw materials for food purposes, to obtain a dye with a natural red-violet pigment, namely Amaranthin [4]. The group of authors has developed a multicomponent concentrate, in which a dry leaf of amaranth variety “Valentina” is used as extractive substances. The resulting concentrate provides a harmonizing taste and physiological effects on the organs and systems of the body, allows you to activate the body’s metabolism, strengthens the body’s defenses from the negative effects of the environment and allows you to expand the range of multicomponent concentrates with preventive action [5], [6]. Obtaining the maximum amount of amaranth dry leaf with minimum cost is necessary to produce large quantities of multicomponent concentrate.
2. Materials and Method
Amaranth plants were grown in open ground on sod-podzolic soil at the greenhouse base of the Federal Scientific Center for Vegetable Growing in the Moscow Region. Production experiments using conventional methods in vegetable farming were carried out [7]. Amaranth leaves, collected from three weeks before flowering and a week after flowering, were dried to a residual moisture content of 10% in a drying cabinet at 80 °C.

The economic efficiency of growing amaranth in an open and protected ground in the control and experience (with the introduction of mineral supplementation at a dose of 70 kg / ha of active substance at a wholesale price of 22 thousand rubles per ton) was determined on the basis of charts of growing amaranth according to the method of determining economic efficiency [8], [9]. Realization cost of amaranth leaf mass was calculated according to the selling prices of the Federal Scientific Center for Vegetable Growing. The table shows the average values.

3. Results and Discussion
Amaranth leaves contain protein (15–20%), including a balanced composition of essential amino acids, a complete set of vitamins B, E, C, carotenoids, flavonoids (rutin, quercetin, etc.), simple phenolic compounds, hydroxycinnamic acids. The content of ascorbic acid in amaranth leaves is in the range from 8 to 33%, also there are biologically active substances with antioxidant activity are present (carotenoids, flavonoids, methionine, selenium, red amaranth pigment betacinin amarantine). When cultivating amaranth varieties “Valentina” and “Don Pedro,” as a raw material for the preparation of the dye, it is optimal to collect their leaves starting from the 8th order (three weeks before flowering), at the moment of maximum accumulation of biologically active substances. Earlier, it was shown that the yield of amaranth leaf biomass was highly dependent on doses of nitrogen fertilizer [10].

The yield of the marketable leaf “Valentina” in the open ground was 100 kg / ha in the control without applying additional fertilizing, and the yield was 140 kg / ha in the experiment with introduction. However, when it is grown in the greenhouse, the yield of the commodity raw material was 300 kg / ha in the control, and the yield was 350 kg / ha with the introduction of top dressing.

In comparison with the control, the cost was 1.2 times lower. Indicators of economic efficiency are presented in Table 1.

Table 1. Economic efficiency of cultivation of amaranth varieties for the production of natural food raw materials using mineral supplements in open and protected ground conditions of the Moscow region.

| Growing conditions | Experience Options | Indicators |
|--------------------|-------------------|------------|
|                    | Production costs, thousand rubles / ha | Amount of leaf biomass, kg / ha | Costs, rub / kg | Product price, rub / kg | Gross profit, thousand rubles / ha | Profitability, % |
| Open ground        | Control            | 75         | 100      | 750        | 1000        | 25                | 33               |
|                    | Top dressing       | 77         | 140      | 550        | 1000        | 63                | 81               |
| Greenhouse         | Control            | 220        | 300      | 733        | 1000        | 80                | 36               |
|                    | Top dressing       | 225        | 350      | 643        | 1000        | 125               | 56               |
| Don Pedro          | Control            | 75         | 90       | 830        | 1000        | 15                | 20               |
|                    | Top dressing       | 77         | 120      | 640        | 1000        | 43                | 56               |
| Open ground        | Control            | 220        | 250      | 880        | 1000        | 30                | 14               |
|                    | Top dressing       | 225        | 290      | 780        | 1000        | 64                | 28               |
In a protected ground, when growing the Valentine's amaranth variety at a high cost (220 thousand rubles), the cost of these products corresponds to the level of being grown in open ground, but the amount of leaf biomass is 3 times higher. The option of growing in a greenhouse with the addition of top dressings was also distinguished by a high profit from the sale. In comparison to open ground, the cost is reduced by about 1.2 times.

In the “Don Pedro” variety, the yield of finished commercial raw materials of the open ground (also taking into account the collection of leaves two weeks before flowering) averaged 90 kg / ha in control (without top dressing), and the yield was 120 kg / ha in the experiment (using top dressings, respectively).

It should be noted that in greenhouses, the yield of leaf biomass was 250 kg / ha in the control and the yield was 290 kg / ha with the addition of top dressing at the “Don Pedro” variety.

4. Conclusion
It has been shown that when grown in both open and protected soil conditions of the Federal Scientific Center for Vegetable Growing (Moscow region, Russia), with the initial wholesale price of 1 thousand rubles per 1 kilogram, both varieties were profitable when grown both in open ground and in the greenhouse. At the same time, the variant with the use of mineral top dressing when grown in the open ground is most cost-effective in the cultivation of the “Valentine” leaf amaranth variety for obtaining natural dye with a profitability of 81%. In this variant, cultivation of the “Don Pedro” variety shows profitability up to 56%. The maximum yield of leaf biomass when growing both species of amaranth is achieved in a film greenhouse using top dressing, and reaches 350 kg per hectare, in the case of “Valentine” variety.

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