Chemistry of Natural Compounds, Vol. 34, No. 1, 1998

PIGMENT COMPONENTS OF AMARANTHACEAE

M. T. Turakhozhaev, M. A. Khodzhaeva, T. D. Kasymova, and M. A. Abduazimova

UDC 562.998.577 (479.24) 156

Water-soluble pigments have been isolated from the epigeal parts of some Amaranthaceae species. A method for their production has been developed and the amounts of the main coloring substances in them have been determined. Protein components have been isolated by the subsequent treatment of the residual raw material, and their amino acid compositions have been determined.

The increasing interest in *Amaranthus* is due to the fact that plants of this genus are rich in biologically active compounds and are a valuable food crop [1, 2].

There is information in the literature on the presence of pigments in some *Amaranthus* species [3, 4]. We have studied cultivated and decorative species and have found new pigments. Five species of *Amaranthus* growing in the Republic of Uzbekistan were investigated.†

Amaranthus caudatus is cultivated in gardens and parks as a decorative plant, while the other *Amaranthus* species were obtained by breeding. The air-dry raw material was subjected to extraction with water in reactors. The aqueous extracts changed color when they were concentrated in a rotary evaporator under vacuum. Subsequently, therefore, aqueous extracts of the water-soluble pigments (WSPGs) were fed directly into an Anhydro-2 apparatus (Denmark) for spray-drying.

The yields of WSPGs and their contents are given in Table 1.

As can be seen from Table 1, the *Amaranthus* species differed in their contents of WSPGs. The WSPGs consisted of odorless and tasteless powders from pink to red in color, although all their aqueous solutions were red. On standing, aqueous solutions of the WSPGs gave a turbidity, and for this reason the aqueous extract of A-K-283 was subjected to ultrafiltration in an Alpma apparatus (FRG). After ultrafiltration the yield of final product had fallen and the pigment content had increased through the elimination of low-molecular-mass substances (see Table 1). For the quantitative determination of the pigments (PGs) we used the photoelectrocolorimetric method described in [6].

The pulp of *Amaranthus caudatus* after the extraction of the WSPGs was subjected to extraction with 1 M NaCl at pH 9.3 in a ratio of 1:10. The amount of protein in the extract was 23% on the dry raw material.

The amino acid composition of the proteins was determined after acid hydrolysis on an LKB-410 amino acid analyzer (Sweden) (the results are given as percentages of the raw material): Asp 7.1; Thr‡ 3.5; Ser 2.3; Glu 10.3; Pro 3.4; Gly 3.9; Ala 2.2; Val‡ 3.4; Met 0; Ile‡ 2.7; Leu‡ 5.1; Tyr‡ 2.1; Phe‡ 2.8; His 1.5; Lys 3.8; total 56.5 [sic]. Arg and Cys were not identified on the spectral chromatogram.

The molecular masses of the protein components, determined by gel filtration in a thin layer of Sephadex [7], amounted to 18,000-30,000 Da.

The amino acid scores of the essential amino acids were determined (Thr — 60; Val — 66; Ile — 60; Leu — 69; and Tyr+Phe — 55) established by the WHO [8]. The biological value of the pigment complex of *Amaranthus caudatus*, which is recommended for use in the food industry, was determined (32%).

†Samples of four of the *Amaranthus* species were provided by K. S. Safarov.

‡Essential amino acids.

Institute of the Chemistry of Plant Substances, Academy of Sciences of the Republic of Uzbekistan, Tashkent, fax (3712) 40 64 75. Translated from Khimiya Prirodnykh Soedinenii, No. 1, pp. 57-59, January-February, 1998. Original article submitted May 25, 1997.

 0009-3130/98/3401-0042$20.00

TABLE 1

Amaranthus species	Yield of WSPGs	*C*, %	*D*	*N*, %	*C*, %	*D*	*N*, %
A. tricolor	6.7	0.33	0.45	5.2	0.75	0.8	9.5
A -1011	8.0	0.33	0.6	6.0	0.75	1.1	12.9
A-K-283	6.8	0.33	0.5	5.6	0.75	1.0	11.6
A-K-283*	3.8	0.20	1.5	68.1	0.25	2.1	73.9
A. argentica	3.8	0.33	0.55	8.3	0.75	0.9	15.4
A. caudatus	3.7	0.33	0.58	8.7	0.75	0.96	15.8

Note. *C* is the concentration of the solution, *D* the optical density, and *N* the pigment content. A-K-283* was formed after ultrafiltration.

EXPERIMENTAL

The WSPGs were extracted from the air-dry raw material that had been ground and passed through a sieve with apertures having a diameter of 3 mm.

The extraction of the WSPGs from all the *Amaranthus* species was carried out in the following way. The comminuted raw material was charged into a 20-liter reactor, and water was added in a ratio of 1:10. After three hours' steeping the reactor was unloaded. The filtrates were fed to an Anhydro-2 apparatus for spray-drying. On repeated extraction, the A-K-283 sample was passed through an Alpma ultrafiltration apparatus (FRG). Modules of Carbosep C-55 filters. After clarification on the ultrafilters the WSPG sample A-K-283 was fed to spray drying and gave the WSPG sample A-K-283*. The amount of PG was determined on a KFK-2 photoelectrocolorimeter at a wavelength of 420 nm. A solution of cobalt sulfate was used as standard [6].

For the maximum extraction of protein from *Amaranthus* plants, the raw material was extracted with an alkalinized 1 M NaCl solution, pH 9.3. Then ammonium sulfate was added to the supernatant (44 g of ammonium sulfate to 100 ml of solution). The protein that precipitated was separated off, dialyzed to eliminate salts completely, and freeze-dried.

The amino acid composition of the protein preparation was determined on a LKB-410 amino acid analyzer after hydrolysis with 5.7 N HCl at 110°C for 24 h. The hydrolysate was filtered, evaporated in a rotary evaporator at 40°C, and left over solid KOH for 18 h. Then the hydrolysate was dissolved in acetate buffer, pH 5.4, and transferred to the column of the amino acid analyzer.

REFERENCES

1. R. Becker and E. I. Wheeler, J. Food Sci., **46**, 1175 (1982).
2. F. W. Martin and I. Telek, Vegetables for the Hot, Humid Tropics. Part 6: *Amaranthus* and *Celosia*, USDA, New Orleans (1979).
3. T. V. Chernenko, M. A. Khodzhaeva, A. I. Glushenkova, and M. T. Turakhozhaev, Khim. Prir. Soedin., 797 (1997).
4. M. A. Kasumov, Pishch. Prom-st, No. 12, 75 (1991).
5. Yu. G. Sporikova and É. P. Shaftan, Inventors' Certificate 187192; Byull. Izobret., No. 20 (1966).
6. S. A. Salikhov, Dye Plants for the Food Industry [in Russian], Fan, Tashkent (1985).
7. M. K. Gil'manov, O. V. Fursov, and A. P. Frantsev, Methods of Purifying and Studying Plant Enzymes [in Russian], Nauka, Alma-Ata (1981).
8. I. M. Skurikhin and A. P. Nechaev, All About Food from a Chemist's Point of View [in Russian], Vysshaya Shkola, Moscow (1991).