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ANALYSIS OF CHLOROPHYL “α”, “β” AND CAROTINOIDS IN THE LEAVES OF LOCAL AND FOREIGN VARIETIES AND SPECIMENS OF SORGHUM

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Abstract
This article presents the chlorophyll-α, chlorophyll-β and carotenoids in the leaf content of local and foreign varieties and samples of sorghum obtained from the international organization ICBA and the collection of the Scientific and Experimental Station of Fodder Crops of the Republic of Uzbekistan.

Keywords: Sweet sorghum (Sorghum bicolor L. (F-138) sample, Oranjevoe 160, chlorophyll "α" and "β", carotenoids, total pigments, photosynthesis, light energy, local and foreign sorghum.

Introduction

Sorghum (Sorghum bicolor) is an important food crop consumed by millions of people as a staple food. It is a staple crop in arid and semi-arid regions of the developing world, especially in Africa. In the developed world, including Australia and the United States, sorghum is mainly grown for industrial purposes such as animal feed and bioethanol production. However, due to increasing evidence and awareness of its health benefits, sorghum is increasingly being consumed in food markets in developed countries. [4,1].

Among the many cereal crops, sorghum (Sorghum bicolor) is well-adapted to the environmental conditions of semi-arid regions due to its drought and heat tolerance [5].

According to the latest FAOSTAT report, sorghum production in 2017 was 57.6 million tonnes [11].

Chlorophyll is a green pigment found in plants, algae, and photosynthetic bacteria. In plants, chlorophyll is responsible for absorbing light energy and converting it into chemical energy during photosynthesis. Chlorophyll is called the central pigment of the photosynthetic reaction because it converts light absorbed by other pigments into chemical energy during photosynthesis [2]. The

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chlorophyll content is considered an indicator of photosynthetic activity [6]. Most researchers believe that the ratio of chlorophyll "α" to chlorophyll "β" is 3:1. These values vary depending on the growth and development of plants, the plant variety, and a number of environmental factors. Chlorophyll also plays an important role in the process of plant organogenesis [10]. According to some studies, chlorophyll synthesis depends on mineral nutrition. Mineral nutrition significantly affects the dynamics of leaf surface formation and leaf surface area, that is, the total amount of leaf surface, photosynthetic potential and net photosynthesis. Chlorophyll has the greatest impact on plant development among all macrometabolic elements, and nitrogen on the total and leaf surface, and its effect is enhanced by phosphorus and potassium [3].

Materials and methods. The study was conducted at the experimental site and the scientific laboratory of the Department of "Genetics and Evolutionary Biology" of the Faculty of Natural Sciences of Chirchik State Pedagogical University. The research object was a sample of Sorghum bicolor (F-138) belonging to the Sorghum bicolor L. species obtained from the international organization ICBA and domestic and foreign varieties of sorghum Oranjevoe-160, Karabash, Marjon, Nis15-01 (India), Massino, Uzbekistan-5, Daulet, Kanibodomsky Beloe from the collection of the Forage Crops Scientific and Experimental Station of the Republic of Uzbekistan. In the experiment, the amounts of chlorophyll "α", "β" and carotenoids in the leaves of plants of Sorghum bicolor L. species and local and foreign varieties of sorghum obtained from the collection of the Scientific and Experimental Station of Forage Crops of the Republic of Uzbekistan were determined. In this case, samples were taken from the 3-4th leaf, counting from the growth point of the plant in field conditions. Each leaf was placed in a test tube at 50 milligrams. Each leaf sample was homogenized in 5 ml of 95% ethyl alcohol solution [7]. The homogenate was centrifuged at a speed of 5000 for 12 minutes. The amounts of chlorophyll "α", chlorophyll "β" and carotenoids in the resulting extract were determined using an Agilent Cary 60 UV-Vis spectrophotometer at light absorption indices of 664, 649 and 470 nm. Based on this indicator, the amounts of chlorophyll "α", chlorophyll "β", and carotenoids in plant leaves were calculated using the following equation [9].

chlorophyll "α" [mg/g] =13.36A664–5.19* A649

chlorophyll "β" [mg/g] =27.43A649 –8.12* A664

carotenoid [mg/g] = (1000A470 –2.13*Chlo "a"– 97.63 Chlo "b")/209

F (Mg/g)=(V*S)/P.

Research results and discussions.

The objects of the research were a sample of Sorghum bicolor (F-138) belonging to the Sorghum bicolor L. species obtained from the international organization ICBA and the results of the analysis of the chlorophyll-"α", "β", total chlorophyll and carotenoid content in local and foreign varieties of sorghum obtained from the collection of the Forage Crops Scientific and Experimental Station of the Republic of Uzbekistan in the plant leaves during the budding, tuberous, tillering, flowering and ripening phases.

The amount of chlorophyll-"α" in the tillering phase was different in the Sorghum bicolor (F-138) sample of Sorghum bicolor L. species and in the local and foreign varieties of sorghum obtained from the collection of the Scientific and Experimental Station of Fodder Crops of the Republic of Uzbekistan. In particular, the amount of chlorophyll-"α" in the Sorghum bicolor (F-138) sample was 14.86 mg/ml. The highest indicator of this characteristic in local samples was 22.93 mg/ml in

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webofjournals.com/index.php/8

the Oranjevoe-160 variety, while the lowest indicator of this characteristic was 12.16 mg/ml in the Kanibodomsky beloe variety. The lowest indicator of chlorophyll-"α" content in the tuberous phase in foreign and local varieties and samples was found to be 21.88 mg/ml in the Sorghum bicolor (F-138) sample, and the highest indicator of this characteristic was 26.00 mg/ml in the Daulet variety. The highest chlorophyll-"α" content in the budding phase was 23.94 mg/ml in the Nis 15-01 (India) sample, and the lowest was 17.62 mg/ml in the Oranjevoe-160 variety. The highest chlorophyll-"α" content in the flowering phase was 22.82 mg/ml in the Uzbekistan-5 variety, and the lowest was 17.39 mg/ml in the Marjon variety. The lowest chlorophyll-"α" content in the ripening phase was 9.35 mg/ml in the Oranjevoe-160 variety, and the highest result for this trait was 23.52 mg/ml in the Uzbekistan-5 variety. (Table 1).

In the studied varieties and samples, the highest indicator of chlorophyll-"β" was determined in the tube phase, while the lowest indicator was 4.11 mg/ml in the Massino variety. The highest indicator of chlorophyll-"β" in the tube phase was 8.18 mg/ml in the Oranjevoe-160 variety, the same 15.57 mg/ml in the Oranjevoe-160 and Daulet varieties, and the lowest indicator was 9.68 mg/ml in the Foreign Sorghum (F-138) sample. In the rooting phase, the chlorophyll-"β" content was the highest in the Massino variety, 20.25 mg/ml, and the lowest indicator was 6.80 mg/ml in the Oranjevoe-160 variety. The highest chlorophyll-"β" content in the flowering phase was 10.96 mg/ml in the Oranjevoe-160 variety, while the lowest was 7.66 mg/ml in the Marjon variety.

In local and foreign sorghum varieties and samples, the highest carotenoid content in the tillering phase was observed in the Daulet variety (5.01 mg/ml) and the lowest in the Kanibodomsky Beloe variety (3.05 mg/ml). In the tuberous phase, the Daulet variety had a slightly lower carotenoid content (3.83 mg/ml) than other varieties and samples, while the Karabash variety had a higher content (4.65 mg/ml) than the others (Table 2). In the tillering phase, the highest carotenoid content was observed in the Kanibodomsky Beloe variety, and the lowest was in the Massino variety (2.20 mg/ml). The highest rate in the flowering phase according to the same indicator.

Table 1 Mahalliy va xorijiy jo'xori nav va namunalarida xlorofill "α", "β" konsentratsiyasi (mg/ml)

№	Samples	Chlorophyll-"α"				Chlorophyll- "β"					
		accumulation	tube	fertilizing	flowering	tillering	accumulation	tube	fertilizing	flowering	tillering
		$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$
1	Oranjevoe-160	22,93±0,08	25,77±0,72	17,62±1,62	21,89±0,72	9,35±2,53	8,18±0,17	15,57±2,66	6,80±0,81	10,96±0,84	4,63±1,33
2	Karabash	15,76±3,10	24,19±0,72	23,37±1,33	20,16±4,74	13,30±4,38	5,24±1,55	11,53±1,14	12,75±3,66	9,74±2,15	5,39±1,79
3	Marjon	18,62±3,57	23,27±2,85	20,67±0,92	17,39±2,79	10,46±2,28	6,17±1,85	12,78±3,50	8,10±0,70	7,66±1,49	4,09±0,64
4	Nis 15-01	19,81±2,12	25,07±0,83	23,94±1,31	18,93±2,27	16,42±2,16	6,54±1,41	12,58±1,86	15,69±3,73	8,92±1,54	7,05±1,05
5	Sorghum bicolor(F-138)	14,86±1,78	21,88±1,68	19,03±3,04	20,12±1,63	12,02±2,31	4,25±0,55	9,68±1,41	7,28±1,83	9,98±0,88	5,22±1,27
6	Massino	14,86±2,00	24,00±0,48	23,63±1,40	20,94±2,54	19,37±1,63	4,11±0,95	10,49±0,57	20,25±4,62	10,48±3,16	7,14±0,82
7	Uzbekistan-5	19,30±1,22	24,74±0,67	23,20±0,34	22,82±1,22	23,52±1,50	5,82±0,64	11,42±1,19	9,61±0,23	10,17±1,96	11,82±3,14
8	Daulet	19,22±0,84	26,00±0,32	22,65±0,37	20,22±3,01	12,98±1,31	5,77±0,56	15,57±1,79	8,85±0,27	7,97±2,20	5,86±0,53
9	Kanibodomsky beloe	12,16±2,33	25,05±0,63	21,97±0,33	20,82±3,03	19,41±1,74	3,60±1,09	12,58±1,44	7,72±0,86	9,11±2,81	7,15±0,92

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Table 2 Carotenoid content and total pigment concentration in local and foreign sorghum varieties and samples (mg/ml)

№	Samples	Carotenoid content					Total pigment concentration				
		accumulation	tube	fertilizing	flowering	tillering	accumulation	tube	fertilizing	flowering	tillering
		$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$	$\bar{x} \pm s \bar{x}$
1	Oranjevoe-160	4,39±0,08	4,45±0,34	3,87±0,31	4,49±0,65	1,82±0,37	31,10±0,19	41,34±3,36	24,42±2,43	32,84±0,23	13,98±3,86
2	Karabash	3,34±0,44	4,65±0,10	3,94±0,49	3,80±1,05	3,17±1,13	21,00±4,65	35,72±1,83	36,12±4,98	29,90±6,72	18,69±6,13
3	Marjon	3,78±0,45	4,21±0,43	4,48±0,18	3,36±0,43	2,31±0,48	24,79±5,39	36,05±6,21	28,77±1,62	25,05±4,20	14,56±2,90
4	Nis 15-01	3,92±0,22	4,46±0,19	3,18±0,71	3,59±0,28	3,17±0,47	26,34±3,50	37,64±2,67	39,64±4,40	27,86±3,80	23,47±3,08
5	Sorghum bicolor(F-138)	3,54±0,39	4,47±0,08	3,60±0,49	3,69±0,20	2,36±0,22	19,11±2,33	31,57±3,09	26,31±4,87	30,11±2,50	17,24±3,59
6	Massino	3,63±0,29	4,63±0,14	2,20±1,06	3,63±0,10	4,03±0,31	19,60±2,96	34,49±1,02	43,89±4,26	31,42±5,68	26,51±2,41
7	Uzbekistan-5	4,11±0,06	4,22±0,06	4,90±0,20	4,66±0,32	4,24±0,29	25,12±1,86	36,16±1,85	32,81±0,56	33,00±3,19	35,35±4,63
8	Daulet	5,01±0,30	3,83±0,32	4,72±0,10	4,18±0,51	2,47±0,46	25,00±1,36	41,57±2,11	31,51±0,58	28,19±5,15	18,84±1,39
9	Kanibodomsky beloe	3,05±0,48	4,00±0,23	5,38±0,59	3,92±0,31	4,50±0,42	15,76±3,35	37,63±2,02	29,69±0,53	29,93±5,80	26,56±2,66

The Uzbek-5 variety had 4.66 mg/ml, and the lowest was 3.36 mg/ml in the Marjon variety. The highest carotenoid content in the ripening phase was recorded in the Kanibodomsky Beloe variety, while the Oranjevoe-160 variety had a slightly lower result than other varieties and samples.

The total pigment content of local and foreign sorghum varieties and samples was analyzed during the budding phase. In particular, the lowest result in terms of the total pigment content of the studied varieties and samples was observed in the Kanibodomsky Beloe variety (15.76 mg/ml), while the highest result was observed in the Oranjevoe-160 variety (31.10 mg/ml).

The total pigment concentration in the studied collection samples and local varieties in the budding phase was the highest in the Daulet variety (41.57 mg/ml), the lowest in the Sorghum bicolor (F-138) sample (31.57 mg/ml). In the budding phase, the highest result for the same indicator was determined in the Massino variety (43.89 mg/ml), and in the Oranjevoe-160 variety (24.42 mg/ml), which was slightly lower than other varieties and samples. In the flowering phase, the highest indicator for the concentration of total pigments was in the Uzbekistan-5 variety (33.00 mg/ml), and a slightly lower indicator was in the Marjon variety (25.05 mg/ml). In the ripening phase, the highest result was recorded in the Uzbekistan-5 variety (33.00 mg/ml), while the lowest result was observed in the Oranjevoe-160
variety (Table 2).

Conclusion

When spectrophotometric analysis of chlorophyll “α”, “β”, total pigments and carotenoid content in the leaves of Sorghum bicolor L. and local and foreign varieties of sorghum was performed, chlorophyll “α” – 22.93 mg/ml and chlorophyll “β” – 8.18 mg/ml in the Oranjevoe-160 variety in the budding phase, carotenoid content in the Daulet variety was 5.01 mg/ml, Oranjevoe-160 variety had a high total pigment content of 31.10 mg/ml, in the tuberous phase, chlorophyll “α” – 26.00 mg/ml in the Daulet variety, chlorophyll “β” – 15.57 mg/ml in the Oranjevoe-160 and Daulet varieties, carotenoid content in the Karabash variety was 4.65 mg/ml, total pigments in the Daulet variety was 41.57 mg/ml, In the phase, it was found that the content of chlorophyll "a" in the Nis 15-01 sample was 23.94 mg/ml, the content of chlorophyll "β" in the Massino variety was 20.25 mg/ml, the content of carotenoids in the Kanibodomsky Beloe variety was 5.38 mg/ml, and the

content of total pigments in the Massino sample was 43.89 mg/ml.

In the flowering phase, it was found that the Uzbek-5 variety had a higher chlorophyll "α" content of 22.82 mg/ml, the Oranjevoe-160 variety had a higher chlorophyll "β" content of 10.96 mg/ml, the Uzbek-5 variety had a higher carotenoid content of 4.66 mg/ml, and the Uzbek-5 variety had a higher total pigment content of 33.00 mg/ml.

In the ripening phase, it was found that the Kanibodomsky Beloe variety had a higher chlorophyll "α" content of 19.41 mg/ml, the Uzbek-5 variety had a higher chlorophyll "β" content of 11.82 mg/ml, the Kanibodomsky Beloe variety had a higher carotenoid content of 4.50 mg/ml, and the Kanibodomsky Beloe variety had a higher total pigment content of 26.56 mg/ml.

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