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LIPID-CARBOHYDRATE COMPOSITION OF *Hibiscus esculenthus*

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The lipid composition of ripe and green fruit of Hibiscus esculenthus *cultivated in Uzbekistan was studied. The fatty-acid composition of pod and seed lipids was determined. Carbohydrate components including water-soluble polysaccharides, pectinic substances, and hemicellulose were characterized.*

Key words: *Hibiscus esculenthus*, lipids, fatty acids, carbohydrates, mucilage.

Hibiscus esculenthus L. (Malvaceae, okra) is an African species that grows in many parts of the world, e.g., India, Malaysia, Middle Asia, etc. [1]. The seeds are rich in protein, lipids, Ca, Fe, vitamin C, and carbohydrates. Green fruit (GF) is edible and used both raw and fried. Okra is used in folk medicine as a diuretic and anticatarrhal remedy [2].

The fatty-acid composition of lipids from separate organs of *H. esculenthus* has previously been studied [3-5]. Cyclopropenoid fatty acids (CFA) [4] and hydroxyacids (HA) [6] were isolated in addition to the usual fatty acids. The gossypol content in okra seeds is insignificant (0.0032%) [1].

Four polysaccharides from *H. moscheutes* pods exhibited hypolipidemic activity [7]; water-soluble polysaccharides (WSPS) of *H. sabdariffa*, antianaphylactic activity analogous to that of diazoline [8]. Data on the polysaccharide composition of *H. esculenthus* fruit have not been reported.

We investigated green (GF) and ripe (RF) okra fruit cultivated in Uzbekistan. Fruit was separated into pods and seeds, ground, and extracted with $CHCl_3$. WSPS, pectinic substances (PS), and hemicellulose (HC) was extracted from the defatted raw material of RF.

The lipids were light-yellow.

Table 1 shows that the main mass of GF consisted of pods (85.3%); of RF, 59.4%. The lipid content of pods and seeds of GF is almost the same. Seed lipids make up the main mass of RF (19.5%).

The neutral lipids of GF and RF were analyzed by TLC using systems 1-3. The following lipid classes were identified: hydrocarbons, esters of high-molecular-weight alcohols, triacylglycerides, tocopherols, free fatty acids, triterpenols, and sterols. The pods of GF contained chlorophyll pigments. Esters of high-molecular-weight alcohols dominated the pod lipids. Triacylglycerides made up the main mass of ripe-seed lipids. Qualitative reactions for the presence of HA and CPA in the lipids were positive. Epoxyacids were detected only in lipids of ripe seeds. This is consistent with their synthesis during fruit ripening [4].

CPA were found in lipids of GF and RF. However, they dominated lipids of RF. The fatty-acid composition was determined by GC (Table 2).

Lipids of pods and seeds contained the same set of fatty acids. Pod lipids of RF had more saturated fatty acids than those of GF (by 17.3%). Unsaturated fatty acids dominated seed lipids of RF. The principal acids in lipids of green pods were 16:0 and 18:2; in lipids of seeds, 16:0, 18:0, 18:1, and 18:2; in lipids of ripe seeds, 16:0, 18:1, 18:2; in pods, 16:0, 18:0, 18:1, and 18:2.

After isolating lipids, the pulp was dried and used for extraction of various polysaccharide (PSD) fractions: WSPS, PS, and HC.

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TABLE 1. Properties of *H. esculenthus* Fruit

Plant part	Content, %			
	mass	$CHCl_3$ extract	nonlipid components	lipids
Green fruit:				
pods	85.3	4.2	2.2	2.0
seeds	14.7	3.8	1.7	2.1
Ripe fruit:				
pods	40.6	1.9	0.8	1.1
seeds	59.4	21.8	2.3	19.5

TABLE 2. Fatty-Acid Composition of *H. esculenthus* Lipids, GC, wt. %

Plant part	Fatty acids											
	12:0	14:0	15:0	16:0	17:0	18:0	20:0	18:1	18:2	18:3	Σ_{sat}	Σ_{unsat}
Green fruit:												
pods	0.9	0.2	0.8	30.3	1.2	8.2	3.7	8.3	40.3	6.1	45.3	54.7
seeds	1.5	0.7	0.8	23.4	3.0	18.7	3.5	23.7	19.3	5.4	51.6	48.4
Ripe fruit:												
pods	0.5	1.5	0.5	39.4	1.4	16.5	2.8	18.3	18.2	0.9	62.4	37.6
seeds	0.3	0.2	0.6	27.3	2.8	5.7	Tr.	26.4	35.4	1.3	36.9	63.1

The PSD content in RF (wt. %) was: WSPS in pods, 4.1; in seeds, 0.8; PS, 3.7 and 1.4, respectively; HC, 17.4 and 18.1, respectively.

Therefore, WSPS and PS dominate pods of RF. HC is the principal component of seeds and pods. The isolated PSD are white and light-brown (HC) powders. They do not contain starch according to a negative reaction with iodine. WSPS form viscous solutions in water that change color to yellow after treatment with ammonia or NaOH (presence of mucilage). WSPS consist of galacturonic acid, rhamnose, arabinose, glucose, galactose, and traces of xylose. The PS are soluble in water and form viscous colloidal solutions. They have a high positive specific rotation $[\alpha]_D^{20}$ +126° (*c* 0.4, water). This is indicative of the α-configuration of the glycoside bonds between galacturonic acid units.

Pectin contained the following groups according to calculations using titration by the literature method [9] (%): 2.9 free carboxylic acids K_f, 5.1 methoxylated carboyxlic acids K_e, and 58.9% degree of esterification (λ), i.e., it is a highly esterified pectin. The PS contained D-galacturonic acid, rhamnose, arabinose, xylose, and galactose. The principal monosaccharide in HC was xylose. This indicated that it contained a xylan-type polysaccharide.

The results indicate that GF and RF of okra have identical qualitative contents of neutral lipids and FA. The qualitative content of FA of pods and seeds are different. The seeds contain more WSPS and PS. The main mass of PSD in seeds and pods (18.1 and 17.4%, respectively) is HC.

EXPERIMENTAL

GC of FA methyl esters was carried out on a Chrom-4 instrument with a flame-ionization detector, a stainless-steel column packed with 17% PEGS on Chromaton, 198°C thermostatted temperature, 250°C source, and N_2 carrier gas. TLC on silufol and silica-gel plates and paper chromatography (PC) were performed using solvent systems hexane:diethylether (3:7, 1; 5:5, 2; 4:1, 3) and butanol:pyridine:water (6:4:3, 4). Lipids were saponified by the literature method [10]. The soap was decomposed with H_2SO_4 (10%) after removal of unsaponified substances.

FA were isolated by diethylether; WSPS, PS, and HC, by successive treatment of the raw material with water, oxalate buffer at 70°C, and base. PSD were precipitated from the extracts by alcohol. WSPS were obtained from the water fraction; PS, from the buffer; and HC, from the base. PSD were hydrolyzed by H_2SO_4 (2 N) at 100°C for 8-24 h. The hydrolysates were neutralized with $BaCO_3$. The filtrates were evaporated to a syrup. Monosaccharides were analyzed by PC using system 4 and developed using acid aniline phthalate.

The qualitative reaction for epoxyacids used picric acid [11]; for CPA, the Halphen method [12]. Neutral lipids were developed using iodine vapor and H_2SO_4 (50%).

Plants were grown at the Scientific Production Center of the Academy of Sciences of the Republic of Uzbekistan. GF and RF were collected 10 and 45 days after flowering.

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