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EPICUTICULAR WAXES OF HEXAPLOID AND OCTAPLOID TRITICALES

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Key Word Index—Hexaploid and octaploid triticales; Gramineae; epicuticular wax composition; plant hybrids.

Abstract—Leaf and stem wax of triticales contain alkanes, esters, aldehydes, free alcohols, free acids, β-diketones and hydroxy β-diketones. The wax compositions of the triticales investigated are closer to that of wheat than to that of rye.

INTRODUCTION

The composition of the surface lipids of only one triticale hexaploid has been studied so far [1] and it has been found that the wax more closely resembled that of wheat than that of rye. We have carried out similar analyses of the epicuticular waxes of three different triticales, namely (1) strain M_2A_6 which is a secondary hexaploid (AABBDR) obtained from a complex cross involving *Triticum turgidum*, *Triticum aestivum* and *Secale cereale*, (2) strain 611/139, a primary octaploid (AABBDDRR) obtained by crossing *Triticum aestivum* with *Secale cereale*, (3) strain T 151/7, a primary hexaploid (AABBRR) obtained by crossing *Triticum durum* with *Secale cereale*. Our aim was to compare the chemistry of wax from these various amphiploid triticales with those of rye and wheat.

RESULTS AND DISCUSSION

Waxes from whole plants collected 70–75 days after germination at the late booth stage of growth had the yields and composition shown in Table 1. In this and following tables the data of the three lines of triticale are compared with those of durum wheat (line 78-404) and bread wheat (line 78–1947) collected at the same stage of growth. Furthermore, throughout the paper the data of the present work are compared, whenever necessary, with the previously reported data of triticale and rye [1, 2].

Table 1 shows that the yield of wax is appreciably higher for M_2A_6 than for the other two triticales whose amounts are similar to those of durum and common wheat. However, the previously studied triticales and rye had 0.5–0.6% yields in wax [1, 2].

Table 1. Composition and yields of epicuticular waxes of triticales and wheats*

Components	Triticales			Wheats	
	M_2A_6 [AABBDR]	611/139 [AABBDDRR]	T 151/7 [AABBRR]	78-1947 [AABBDD]	78-404 [AABB]
Alkanes	5	6	4	18	9
Esters	7	17	7	15	13
Aldehydes	2	1	1	6	4
Free alcohols	35	54	30	38	25
Free acids	9	8	1	1	2
β-Diketones	16	1	38	14	31
Hydroxy β-diketones	24	10	18	7	15
Unidentified	2	3	1	1	1
Yield (% dry wt)	0.5	0.3	0.3	0.2	0.1
$E^{1\%}_{1cm}$	126	57	134	102	101

*In wt % determined by column chromotography.

Table 2. Composition of alkanes, free alcohols, aldehydes and free acids of triticales and wheats

No. of carbon atoms	Alkanes					Free alcohols					Aldehydes					Free acids		
	M_2A_6	611/139	T151/7	78/1947	78/404	M_2A_6	611/139	T151/7	78/1947	78/404	M_2A_6	611/139	T151/7	78/1947	78/404	M_2A_6	611/139	T151/7
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15	7	36
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	68	25	57
20	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	9	3	3
21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
22	—	—	—	—	—	—	—	—	6	2	—	—	—	1	4	—	2	1
23	2	1	2	1	3	—	—	—	—	—	—	—	—	—	—	—	—	—
24	—	—	—	—	—	3	1	2	14	9	9	1	7	5	18	8	24	2
25	5	4	6	2	4	—	—	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	8	10	13	28	4	10	20	15	21	18	—	13	1
27	12	10	13	16	10	—	—	—	—	—	—	—	—	—	—	—	—	—
28	—	—	—	—	—	89	89	85	50	84	60	56	64	58	41	—	—	—
29	32	31	35	55	65	—	—	—	—	—	—	—	—	—	—	—	—	—
30	—	—	—	—	—	—	—	—	1	1	20	16	13	14	16	—	26	—
31	37	42	30	23	15	—	—	—	—	—	—	—	—	—	—	—	—	—
32	—	—	—	—	—	—	—	—	—	—	—	2	—	—	3	—	—	—
33	12	12	14	3	3	—	—	—	—	—	—	—	—	—	—	—	—	—
Unidentified	—	—	—	—	—	—	—	—	—	—	1	5	1	1	—	—	—	—

Table 3. Composition of esters from waxes of triticales and wheats

No. of carbon atom	Esters				
	M_2A_6	611/139	T151/7	78/1947	78/404
38	2	—	—	1	5
40	5	—	2	3	7
42	8	3	3	5	8
44	22	18	15	24	21
46	9	16	13	22	17
48	17	24	28	21	17
50	21	23	21	18	17
52	6	6	7	4	5
54	3	3	4	1	2
56	7	7	7	1	1

	Alcohols and acids produced by methanolysis of esters									
	M_2A_6		611/139		T151/7		78/1947		78/404	
	Acid	Alcohol	Acid	Alcohol	Acid	Alcohol	Acid	Alcohol	Acid	Alcohol
14	—	—	—	—	—	—	20	—	—	—
16	34	—	18	—	37	—	18	—	15	—
18	10	—	12	—	16	—	18	—	8	1
20	26	—	16	—	37	—	28	—	37	12
22	23	16	38	4	10	11	15	—	32	48
24	4	15	8	6	—	14	1	8	8	18
26	1	10	3	15	—	17	—	22	—	5
28	2	59	5	75	—	58	—	53	—	16
30	—	—	—	—	—	—	—	10	—	—
32	—	—	—	—	—	—	—	7	—	—

The composition of the octaploid 611/139 is significantly different from the two hexaploids. β-Diketones are only 1% and hydroxy β-diketones 10% while alcohols represent the major class reaching 54%. Apart from the presence of hydroxy β-diketones and a lower percentage of aldehydes, wax of 611/139 resembles that of common wheat Demar 4 at seedling stage [3]. Another point distinguishing the three triticales appears to be the relatively higher percentages of hydroxy β-diketones compared with β-diketones in the two common wheat derived strains M_2A_6 and 611/139 when compared with durum wheat derived triticale T 151/7 in which the former class of compounds is more than twice the latter. The overall β-dicarbonyl compound content of the wax was confirmed by the UV absorption value $E^{1\%}_{1\,cm}$ shown in Table 1.

Alkane homologues are more widely distributed in the triticales than in wheat (Table 2). There is an increase in alkanes with longer chains, namely C_{31} and C_{33}, thus suggesting a similarity with rye alkanes in which these are among the dominant homologues.

As aldehydes have not been detected in rye, we can only compare the aldehydes of triticales with those of wheat, from which it appears that in both cereals there is not much chain length specificity, when compared with alcohols, with C_{26}, C_{28} and C_{30} being the major components.

As anticipated, a high chain-length specificity was found for free alcohols, C_{28} being the principal (85–89%) homologue. The major alcohol in rye waxes is hexacosanol, but is octacosanol in both durum and common wheat [1–3]. Free alcohol composition, therefore, clearly resembles that of wheat.

In Table 3 are reported the compositions of esters as such and the major methanolysis products of esters. In the case of triticales the dominant acids were C_{16}–C_{22} esterified with C_{22}–C_{28} alcohols; octacosanol represented 58–75% of the latter class of compound. A comparison with the same compounds of wheat and rye [1, 2] shows a higher chain-length specificity in triticale esters than those of the parent plants. Furthermore, the dominance of the C_{28} chain in the alcohol moiety of triticale esters seems to be directly correlated with those of 78–1947 and 78–404 wheats. Free acids of triticales (Table 2) differ from combined acids in being practically made up of two short-chain acids, C_{16} and C_{18}. Free fatty acids could not be isolated in the two lines of wheat examined.

Hentriacontan - 14,16 - dione was the sole β-diketone found in all plants examined. It was identified by comparison with an authentic sample

and by chemical and MS analysis as previously reported [3, 4]. The same structural determination procedure was used for the identification of hydroxy β-diketones which were a mixture of 8- and 9-hydroxyhentriacontan - 14,16 - diones in triticales M_2A_6 and 611/139, but was 25 - hydroxyhentriacontane - 14,16 - dione in T 151/7. While the latter result is to be expected considering that both durum wheat and rye synthesize the 25-hydroxy β-diketone isomer, the formation of the 8- and 9-hydroxy β-diketones in the cases of triticales M_2A_6 and 611/139 is more remarkable.

Thus, while the results of this study are mostly in agreement with the findings of Tulloch and Hoffman [1], according to whom the wax composition of triticale is controlled by wheat genes, they also indicate some contribution of rye genes because of the alkanes found. The variability observed in the strains investigated was noteworthy especially with regard to β-dicarbonyl composition.

EXPERIMENTAL

Seeds of the three strains of triticale were supplied by Dr. L. Rossi, CNEN, Rome. Wheat seeds were from stocks of our S. Angelo Lodigiano Section. Triticale plants were grown in the field in 1977 and collected in the period 9–20 June 1977; wheat plants were grown in 1978 and collected on 31 May. All plants were harvested 70–75 days after germination at the same stage of growth (late booth stage).

Wax was extracted, chromatographed and analysed as previously described [3, 5]. Esters were examined by GLC on a Dexil 300 support.

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