Phytochemistry, Vol. 20, No. 9, pp. 2143–2144, 1981.
Printed in Great Britain.

0031-9422/81/092143-02 $02.00/0
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INHIBITORY ACTION OF SATURATED FATTY ACIDS AND THEIR DERIVATIVES

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(*Received* 9 *December* 1980)

Key Word Index—*Avena sativa*; Gramineae; coleoptile; growth of coleoptile; inhibitor-β; fatty acid.

Abstract—The inhibitory effects of some saturated fatty acids on the growth of *Avena* coleoptile segments were attributed to the co-existence of a hydrophilic group and an alkyl group with a specific number of carbons. The inhibitory fatty acids and ABA showed a similar behaviour in the course of extraction and paper chromatography.

INTRODUCTION

It is known that some fatty acids and their derivatives show inhibitory activity against the growth of some plant organs [1–4]. One of these saturated fatty acids, decanoic acid, has been isolated from dormant bulbs of *Iris hollandica* Hort. as a growth-inhibiting substance [5]. In this study, the growth-inhibitory activity of selected saturated fatty acids and their derivatives was investigated by the use of the *Avena* coleoptile straight-growth test. In addition, the behaviour of individual inhibitory fatty acids in the course of extraction and paper chromatography (PC) were compared with those of inhibitor-β.

RESULTS AND DISCUSSION

Activity and structure

As shown in Fig. 1, the saturated fatty acids having an effect on the growth of *Avena* coleoptile were limited to those with 8–13 carbon atoms. The comparative inhibitory activities among these fatty acids did not differ in the presence or absence of 0.1 ppm IAA. Among the derivatives of decanoic acid (10:0), the saturated hydrocarbon (decane) and di-carboxylic acid (decanedioic acid) showed no inhibitory activity even at 10^{-2} M, and likewise the aldehyde, chloride and methyl ester were not inhibitory. The activity of either sodium decanoate or 4-cyclohexyl propionic acid was almost the same as that of decanoic acid. Decanol and 4-phenyl butyric acid were slightly inhibitory.

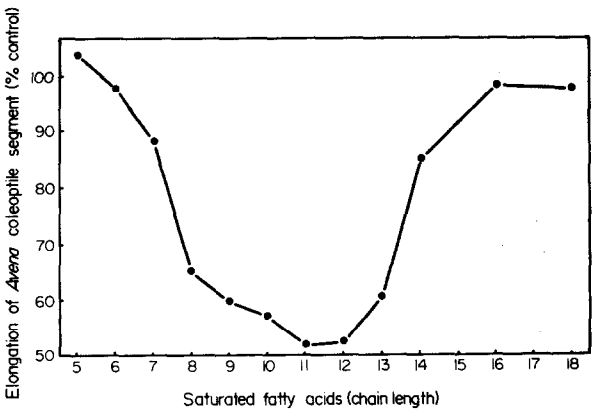

Fig. 1. Inhibitory activities of saturated fatty acids relative to their chain lengths. Bioassay: *Avena* coleoptile straight-growth test; 2×10^{-4} M fatty acid; 0.1 ppm IAA.

Based on the above evidence, it can be concluded that the inhibitory activity was due to the coexistence of a hydrophilic group and an alkyl group with a specific number of carbon atoms. The alkyl group may be replaced by a cyclohexyl group without any decrease in activity. The inhibitory activity of saturated fatty acids on the germination of mustard seeds [2] and axillary bud growth of tobacco [4] has been reported. The results obtained in this study support the specific relationship between the molecular structure and the inhibitory activity of saturated fatty acids, which were reported in earlier papers.

Fractionation and PC

When materials rich in these fatty acids are used for the study of hormonal levels, the question arises as to which fraction will contain activity attributable to these fatty acids. Thus in spite of being acids, saturated fatty acids with an anhydrophilic nature are found in the EtOAc-soluble acidic fraction [5].

When an EtOAc solution containing octanoic (8:0), decanoic (10:0), dodecanoic (12:0) or tetradecanoic (14:0) acids was extracted 4 times with 1/6 its volume of 2% $NaHCO_3$ solution, only 66.5, 16.0, 3.0 or 1.0%, respectively, of each acid was removed from the EtOAc phase. When an amount of 2% $NaHCO_3$ solution equal to that of EtOAc layer was used, 98.5, 57.0, 11.0 or 4.5%, respectively, of each acid was removed. This demonstrated that the amounts of these fatty acids present in a particular fraction were very much influenced by the extraction procedure employed. The longer the carbon chains of the fatty acids, the smaller were the amounts recovered in the acidic fraction.

The R_fs of these inhibitory fatty acids were compared with the R_f of ABA in a PC system (*iso*-PrOH–28%

NH_3–H_2O, 10:1:1) which has been commonly used for hormonal analysis of plant extracts. Although the active area of the histograms of these fatty acids was narrower than that of ABA, the R_f values of the active fatty acids were identical to that of ABA and also to the so-called inhibitor-β as well.

ABA did not completely inhibit the growth of the *Avena* coleoptile even if the concentration was increased up to 10^{-3} M. In contrast, decanoic acid inhibited it completely at concentrations as low as 3×10^{-4} M [5].

Inhibitor-β is supposed to have a significant role in some physiological processes of plant organs. The main component of inhibitor-β may be ABA, but inhibitor-β could possibly contain additional inhibitors [6, 7]. In fact, inhibitor-β obtained from potato tubers showed total growth inhibition of *Avena* coleoptile, but ABA did not [6]. The fatty acids mentioned above have similar solubility and PC properties to those of inhibitor-β. When considerable amounts of inhibitory fatty acids are contained in a plant organ and its extracts, one may possibly detect some of them in an acidic fraction, and also in the inhibitor-β complex.

EXPERIMENTAL

Bioassay. The *Avena* coleoptile straight-growth test [8] was used throughout this study. Selected fatty acids and their derivatives were applied at 2×10^{-4} M unless otherwise stated.

Fractionation of fatty acids. Selected fatty acids (each 200 mg) were dissolved in 150 ml of EtOAc which was then extracted with 25 ml ($\times 4$) or 150 ml ($\times 4$) of 2% $NaHCO_3$ (acidic fraction). The EtOAc layer (neutral fraction) was evapd to dryness and weighed.

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