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BRIEF COMMUNICATION

Amylases during Different Stages of Seed Development in Wheat

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Abstract. The β-amylase activity was high in seeds of pre-milk and milk stages but low in seeds of half seed and dough stages and very low at fully ripe stage of seed development. Zymogen (latent β-amylase) was absent in half seed stage but appeared at pre-milk stage. The content of zymogen increased progressively with advance in ripening time. No α-amylase activity was detected at any stages of seed development in wheat.

In our previous communication we reported how α- and β-amylases mobilize starch and how zymogen gets solubilized at different stages of seed germination (GOSWAMI *et al.* 1977). The present paper deals with similar studies in a system which is just opposite to the seed germination, that is, in developing seeds of wheat at different stages of development after anthesis.

Seeds of wheat cv. S-308 of different stages were obtained from the spikes of different maturity after anthesis. The following stages were recognizable and named accordingly which were taken into study: Stage 1 — half seed stage (7 days after anthesis); Stage 2 — pre-milk stage or watery ripe (14 days after anthesis); Stage 3 — milk stage (21 days after anthesis); Stage 4 — soft dough stage (28 days after anthesis); Stage 5 — hard dough stage 35 days after anthesis) and Stage 6 — fully ripe stage (45 days after anthesis).

0.5 g of seeds in each case were taken and these seeds were homogenized at 4 °C. The crude enzyme was extracted in sufficient amount of phosphate buffer (0.02 M, pH 6.9) and the final volume made to 25 ml. Five ml of the cell extract was subjected to direct estimation of β-amylase activity, while in another 5 ml, 1 ml of 0.2 M mercaptoethanol (MCE) was added and the total β-amylase activity (free + latent) determined following the method as described by MIGIBAYASHI and SHINKE (1967). The zymogen content was determined by subtracting the values of free β-amylase activity from the

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TABLE 1

The levels of β-amylase, zymogen (latent amylase) and α-amylase in developing wheat grain at different stages of development. Data are mean values of 3 independent seed homogenizations

[mg of maltose g^{-1} dry m.]	Stages of seed development [days after anthesis] 7	14	21	28	35	45
β-amylase	159.9	525.0	342.7	211.6	117.0	38.0
Zymogen	0	14.0	209.7	329.5	438.3	492.0
α-amylase	0	0	0	0	0	0

total β-amylase activity. The activity of α-amylase was determined from the β-amylase free cell extract following the methods as described by KRUGER and TRACHUK (1969) and BERNFELD (1955). Values are expressed as units per mg of maltose as determined by 3,5-dinitrosalicylic acid reagent. In each case the absorbance was measured with a Spectronic 20 photocolorimeter at 540 nm against blanks of starch and starch + MCE separately and the values were calculated from a standard curve of maltose and maltose + MCE, respectively.

As is seen from Table 1, the β-amylase activity was high in seeds of early stages of development, that is, up to milk stage except at half seed stage where it was low as compared to pre-milk stage and it decreased subsequently at later stages of maturity. In contrast to this, zymogen (latent β-amylase) was detected only after half seed stage and its content increased progressively at dough and hard dough stages till fully ripe stage. It is noteworthy that α-amylase activity was not detected at any stage of seed development.

The data presented in this paper are indicative of the fact that at early stages of seed formation the activity of β-amylase is quite high but decreases at advance stages of seed ripening. In contrast to this the zymogen content was high at advance stages but very low at early stages of seed development. The fall in amylase activity appears to play an important role in the accumulation of starch in developing grain. The relatively high rate of activity of β-amylase at early stages of seed development may be because of the need for more sugars for cell divisional activity during this period of seed formation. However, the low level of β-amylase activity at half seed stage may be ascribed to the absence of starch at this stage of seed development (unpublished data). The pattern of zymogen content in developing seed is quite interesting and it appears that some part of the active β-amylases are constantly transformed into the inactive form (zymogen) and this partly accounts for the low activity of β-amylase at later stages of seed maturation. The activation of latent β-amylase by MCE treatment indicates that the above mentioned transformation is achieved through double sulphur linkage formation between some chemical constituent and active β-amylases. The significance of zymogen in seed germination has been reported earlier (GOSWAMI *et al.* 1977). Work on this aspect is in progress in this laboratory.

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BOOK REVIEWS

JACOBS, W. P.: PLANT HORMONES AND PLANT DEVELOPMENT. — Cambridge University Press. Cambridge—London—New York—Melbourne 1979. 338 pp. Hard cover £ 18.00, paperback £ 5.95.

This book is written by Professor of Biology at Princeton University who is well known for his extensive research into all the plant hormones. The book is designed for advanced undergraduate and beginning graduate students of biology. The book shows great experience in teaching this subject. It covers the most important aspects of plant growth and development, with the plant hormones controlling them. The biological aspects of hormone action are discussed briefly, physiology and anatomy of action being emphasized. The auxin action is discussed particularly in the chapters devoted to polarity, phototropism, apical dominance and differentiation of vascular tissue. Cytokinins are treated as an integral part of control of bud production, leaf growth and leaf senescence and control of cell division. The gibberellins are presented in connection with the development of theories on regulation of floral development, whereas the action of abscisic acid is described in the chapter of abscision and senescence. On the background of this basic plan a well-balance overview of the interaction of different hormones in all the discussed aspects of plant development is given.

Polar movement of hormones, which lies in the centre of author's own research, is discussed thoroughly in a separate chapter. The author uses the historic approach because, as he says: "The presentation only of the current opinion as to the finished theories distorts the students' understanding . . . it presents a fixed and frozen body of knowledge, whereas the knowledge of science is in fact fluid, challengeable and incremental". The problems are discussed critically, including the most recent findings and theories, the perfection of methods being strongly stressed. A description of the most important methods and an extensive bibliography of selected papers is supplied. The book presents the up-to-date state of developmental plant physiology. Though designed for beginners in science it is useful for the advanced scientific workers engaged in developmental biology. Reading the book one feels with the author that: "aside from art there is probably no human activity where one can approach as close to perfection as in beautifully planned, executed, and interpreted series of scientific experiments".

FRIDETA SEIDLOVÁ (*Praha*)

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This Journal will include a limited number of book reviews. All issues will contain a list of articles to appear in the following issue.

J. ČATSKÝ (*Praha*)