EFFECT OF SUGARS AND LIGHT INTENSITY ON GAMETOPHYTE DEVELOPMENT IN *PTERIS CRETICA* L.

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ABSTRACT

This study is based on observations made during spore germination and gametophyte development in *Pteris cretica* under varying concentrations of sugars as also under varying light intensities. It is observed that the germination of spore was quicker in sugars as compared to that in 1% Knop's solution. It is found that the most effective chemical was 1% d-glucose solution. In sucrose solution (concentration up to 2%) cells of the gametophytes at the filamentous stage increased considerably in length, whereas cell division rate was retarded in solution of concentration higher than 1% to 2%. The chloroplast per cell becomes scanty ultimately perishing in higher concentrations. The gametophytes grown in 3% lactose solution get a vertical division on the third day, subsequently no further divisions occur. The optimum light intensity for normal germination was 600 ft c., but in light intensities of 500-400 ft c. the germination of spores was delayed by 4-10 days. The gametophyte which never assumed its characteristic cordate shape remained much elongated and filamentous.

INTRODUCTION

The effect of various sugars in different concentrations ranging from 1 to 5% and the effect of varied light intensities on the development of gametophytes in *Pteris cretica* were observed. HUREL-PY (1955) studied the effect of some sugars on the development of prothallus of *Alsophila australis*. COURBET (1957) studied the effect of various pentose and hexose sugars on the germination of spores and development of prothallus of *Athyrium filix-foemina*. WHITTIER AND STEEVES (1960) studied the induction of apogamy by higher concentration of sugars in the nutrient medium in gametophytes of Bracken fern. The results of HUREL-PY (1955) and COURBET (1957) are mutually contradictory. We, therefore, wanted to confirm the exact role of sugars on the growth and development of gametophytes of *Pteris cretica*, a plant easily available in the garden.

We carefully observed the effects of lactose, glucose and sucrose as also the effect of various light intensities on the germination of spores and development of gametophytes of *P. cretica*, and the results obtained by us were in general agreement with those of COURBET (1957).

MATERIAL AND METHODS

Spores of *P. cretica* were collected from the fernary of Lucknow University, Botany Department. The spores were taken out from sporangia and allowed to germinate in autoclaved petridishes (sterilized). After their germination they were transferred to different media containing lactose, d-glucose and sucrose in concentrations varying from 1 to 5% in separate dishes. They were also grown under varied light intensities ranging from 400 to 600 ft c. These experiments were carried out at room temperature (26±2°C). Both experimental as well as controlled culture (= Knop's solution without sugars)

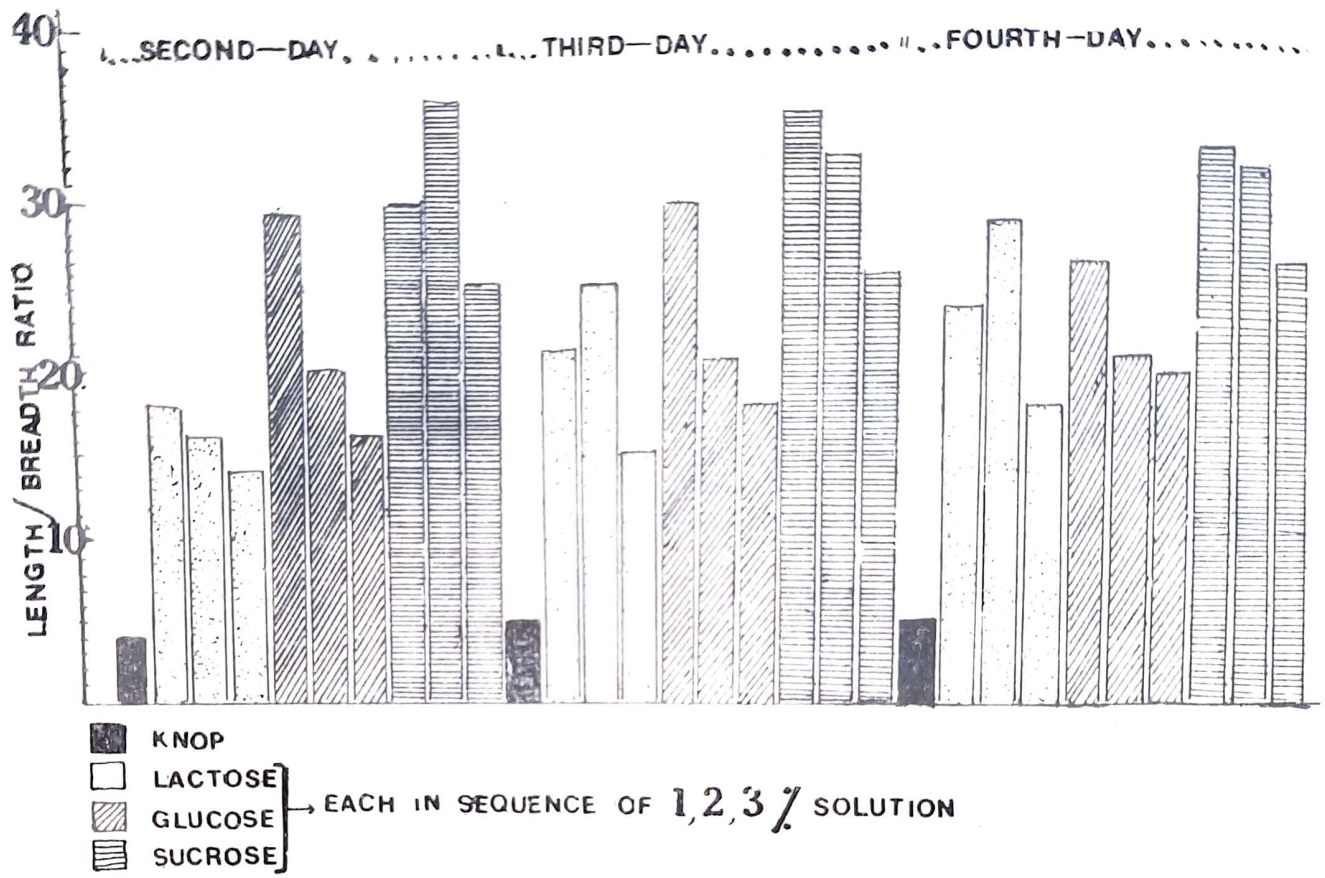
Table 1—Observations

	Normal in Knop's solution	Lactose %					Glucose %					Sucrose %				
		1%	2%	3%	4%	5%	1%	2%	3%	4%	5%	1%	2%	3%	4%	5%
Days required by spores to germinate after sowing	6 to 8 days	5	5	5	5	×	4	5	5	6	6	5	5	6	6	×
Ratio of length/breadth of the cells of gametophyte after 4 or 5 days	5	18.5	16.5	15.7	×	×	29	20	15.5	×	×	30	36	25	×	×
Approximate number of chloroplast in each cell of gametophyte after 1 day	60 to 70	40-50	40-50	less than 30	less than 30	×	60-70	60-70	less than 40	less than 40	less than 40	50-60	50-60	less than 40	less than 40	×
Chloroplast distribution	Uniform throughout each cell	..	..	Irregularly distributed i.e. more agregated at certain points and completely absent from the basal cell												
Number of rhizoids in the gametophyte	5 rhizoids from basal part of filamentous gametophyte	..	..	Total of 2 or 3 rhizaids arise from basal part of filamentous gametophyte												
Time of appearance of first vertical div. in apical cell after spore germination	4th to 6th day when gametophyte is 5 to 6 cells long	×	4th day	3rd day	×	×	4	4	×	×	×	×	×	×	×	×
Days required by prothalli to become cordate	20 to 25 days	Begin to die after 4th day					Between 20-25 days but more narrow and elongated	..	Die after 4th day	×	Die after 6th day			..	Die after 4th day	×
Days required by the sex organs to appear after spore germination	30 to 40 days						No sex organs even after 60-70 days		×						×	

were kept under identical conditions. For every stage of development camera lucida drawings were made. A mean of 10 gametophytes of each stage was taken as a unit.

OBSERVATIONS

The observations noted in Table 1 show that the germination of spores is generally hastened in sugars and is quickest in 1% glucose. No germination occurs in 5% lactose and 5% sucrose. The maximum ratio of length/breadth of cells of the gametophyte was observed in 2% sucrose where the gametophytes become abnormally elongated compared to the cultured ones (see Histogram). Chloroplasts become scanty and get irregularly



Histogram 1.

distributed, i.e. they aggregated at some points in gametophytic filaments in the cultures containing sugars; furthermore, chloroplasts are totally absent from the basal cells of such gametophytes.

The rhizoids are fewer in number in gametophytes grown in sugars as compared to those grown in pure controls.

Vertical division of the apical cell occurred only in gametophytes grown in 2%, 3% lactose and in 1%, 2% glucose while in the rest, the gametophytes generally perished after 4 to 5 days of germination.

Gametophytes continued to grow and assumed cordate shape in cultures with 1% to 2% glucose but no sex organs were produced even after 60 days when the gametophytes started distintegrating.

The germination of spores delayed by 4-10 days in light intensities of 500, 400 ft c. The entire development pattern is thrown off the balance and the gametophyte never assumes the characteristic cordate shape. It is narrow and much elongated. The cells are also narrow and elongated; the number of chloroplasts reduced progressively and ulti-

mately the gametophytes perished. In the light intensity of 600 ft c., the gametophytes were normal and at maturity produced organs.

DISCUSSION

Observation made on the gametophyte development in different sugars with varying concentrations reveals that generally sugars above 2% concentration are inhibitory and 3% lactose inhibits growth 3 days after germination. However, 2% concentration shows that cell elongation is quick but cell division activity is minimum as the gametophytes never grow beyond 5-6 celled stage.

In 1% sucrose the cell elongation is highest but cell division activity is minimum. However, in 1% glucose cell does not elongate much though the cell division is normal. The gametophyte assumes cordate shape but sex organs are not formed.

One can assume that sugars help in carbohydrate metabolism leading to cell elongation but cell division activity gets inhibited except in certain concentrations of glucose.

COURBET (1957) studied the influence of several sugars on the germination of spores of *Athyrium filix-foemina*. Among the pentose sugars, d-ribose and l-arabinose completely blocked germination and d-xylose and l-xylose were inhibitory above 0.01%. The hexose, l-rhamnose and galactose were inhibitory, but d-mannose did not affect germination up to 0.1%. Surprisingly d-glucose up to 2%and d-fructose up to 4% promoted germination. HUREL-PY (1955) reported that 1% glucose and fructose solutions inhibited germination of *Alsophila australis* spores.

WHITTIER AND STEEVES (1960) reported that optimum concentration for the apogamous development of sporophyte in *Pteridium aquilinum* gametophytes was 2.5% glucose. Prothalli grown in the absence of glucose, which have only their photosynthate as an energy source, produced no apogamous structure. They concluded that the role of sugars would consequently seem to be as a respiratory substrate which in some way favoured the induction of apogamy. We have, however, failed to get any apogamous sporophytes in *P. cretica* at the concentration mentioned by WHITTIER AND STEEVES (1960), or even in higher concentration of glucose over considerable time. Our results tend to support the work of COURBET.

Experiments carried out with different light sources show that light intensitiy of 600 ft c is required for the development of gametophyte to reach maturity. Light of lesser intensity inhibits normal development.

REFERENCES

COURBET, H. (1957). Action de quelques sucres sur la germination deset la croissance des prothallus d' *Athyrium filix-foemina* Roth en culture aseptique. *Compt. Rend. Acad. Sci. Paris.* **244:** 107-110.

HUREL-PY. (1955). Action de quelque sucre sur la croissance des prothallus de filicinees. *Compt. Rend. Acad. Sci. Paris.* **240:** 1119-1121.

WHITTIER, D. P. & STEEVES, T. A. (1960). The induction of apogamy in the Bracken fern. *Can. J. Bot.* **38:** 925-930.