Effect of sucrose, glucose and fructose on spore germination of *Riccia gangetica* Ahmad

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***Abstract*- The present study investigates the impact of various sugars, namely sucrose, glucose, and fructose, on the percentage of spore germination in *Riccia gangetica* [1] The outcomes of the study are shown that sucrose concentration of 2.0% resulted in maximum germination. Conversely, glucose exhibited optimal germination at a concentration of 1.0%, while fructose achieved maximal spore germination at a concentration of 0.5%. Our findings suggest that sucrose is the most efficacious carbohydrate source for promoting germination, followed by glucose and fructose, respectively.**

***Index Terms*- Broyophytes, Riccia Gangetica, spore germination, sucrose, fructose**

Introduction

Bryophytes, being highly susceptible to even minute fluctuations in the environmental parameters, have been deemed as an excellent material for conducting experimental studies. The intriguing aspect of bryophytes, which has intrigued several renowned botanists, is their resemblance to the amphibians in the plant kingdom. The immense diversity and adaptable nature of this group have rendered them indispensable for investigating a wide range of botanical issues such as polarity, sex differentiation, alternation of generation and heterochromatin. Owing to its captivating characteristics, bryophytes present a highly promising subject for undertaking fundamental research, encompassing physiological, morphogenetic, and biochemical experiments.

The phenomenon of spore germination plays a pivotal role in the proliferation of a species from one year to the next. A comprehensive examination of the diverse factors that wield an impact on this intricate process would greatly facilitate the comprehension of the underlying mechanisms. In essence, the spore embodies the initial cell of the gametophytic generation and constitutes a highly specialized structure that harbour's the potential to metamorphose into a nascent individual. During germination, the spore undergoes a slight swelling and a concomitant change in coloration, becoming lighter in hue. A fissure emerges in opposition to the tri-radiate mark, ushering in the emergence of the germ tube. Over time, a clearly defined apical cell is established, from which the primary rhizoidal filament emerges at the base of the germ tube. The resultant gametophyte ultimately gives rise to a characteristic rosette. The process of spore germination and the ensuing development of the young gametophyte is contingent upon a multitude of factors. Against this backdrop, the central thrust of the present investigation aimed to scrutinize the effects of distinct sugars (namely, sucrose, glucose, and fructose) on the spore germination capacity of *Riccia gangetica*.

Material and Methods

Living specimens of *Riccia gangetica* were collected from Udaipur during the rainy season. Capsules of *Riccia gangetica* Ahmad were subjected to surface sterilization using a 2% calcium hypochlorite solution. To generate a spore suspension in double-distilled water, the sterilized capsule was ruptured to release the spores. A well-shaken spore suspension (0.01ml) was found to contain approximately 30-40 spores. These spores were then spread on filter paper in each Petri dish. Various percentages of sugar solution ranging from 0.5% to 7% were prepared using a serial dilution technique with Half Knop's liquid Culture Medium. The control in this study was the utilization of pure Half Knop's Medium. Each Petri dish was subjected to 5 ml of a solution with a specified percentage. The growth chamber was utilized, where the Petri dishes were arranged and exposed to fluorescent tube light, with an intensity range of 3500 to 4000 lux, and the temperature was maintained at 23±2°C. The recording of experimental observations was conducted on the 45^{th}, 50^{th}, and 60^{th} day. The minimum number of replicates utilized in each experiment was three, and the experiment was repeated twice.

Result and Discussion

Fulford[3,4] conducted a thorough review of the research on spore germination patterns in acrogynous and *anacrogynous Jungermanniales*. Allsopp and Ilahi proposed that elevated sugar concentrations may disrupt the normal growth of thallus apices. A great deal of research has been conducted by numerous bryologists on the methods of spore germination and the impact of various factors on this process. Inoue[5] conducted research on spore germination and the developmental patterns of protonema in the Marchantiales, including experiments examining the effects of environmental factors such as light and pH, as well as culture media.

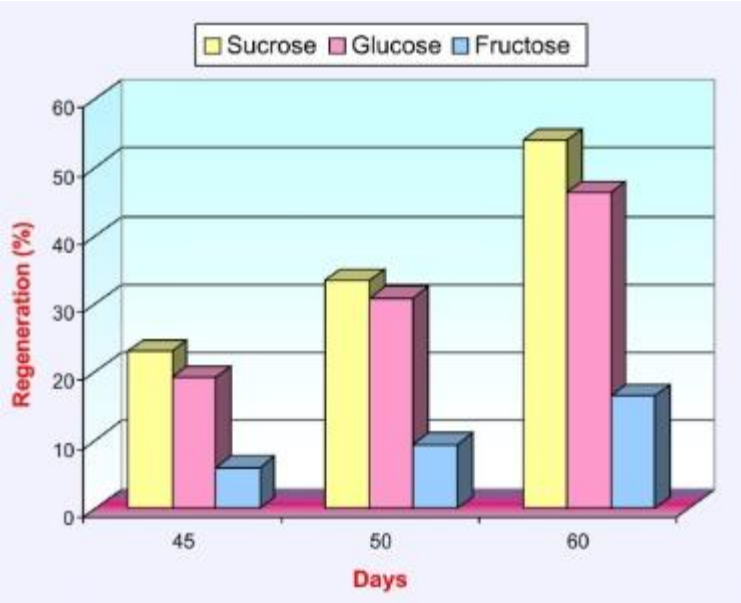

Figure 1: Effect of different sugars on spore germination percentage of *Riccia gangetica* on 45th, 50th and 60th day in Half Knop's Liquid Culture Medium

On the 45th day, it was observed that control led to a spore germination rate of 19.05 percent. Both sucrose and glucose displayed germination up to concentrations of 7%, whereas fructose exhibited germination up to a concentration of 3%. Moving on to the 50th day, a germination rate of 29.523 percent was recorded in the control group. As shown in Fig.-2 that the germination was observed in all concentrations of sucrose and glucose, but in the case of fructose, it was limited to a concentration of 3%. The optimal percentage of ultimate spore germination was found to occur in sucrose at a concentration of 2% (50.48), followed by glucose at a concentration of 1% (45.71) and fructose at a concentration of 0.5% (31.43). The control group exhibited 49.52% germination on the 60th day (as shown in Table-1 and Fig.-1).

Table 1: Showing the effect of different sugars on spore germination percentage of *Riccia gangetica* on 40th, 50th, and 60th day in Half Knop's Liquid Culture Medium

Concentration	45th day				50th day				60th day			
	Sucrose	Glucose	Fructose	Mean	Sucrose	Glucose	Fructose	Mean	Sucrose	Glucose	Fructose	Mean
Control	19.048	19.048	19.048	19.048	29.523	29.523	29.523	29.523	49.523	49.523	49.523	49.523
0.5 %	25.714	24.762	20.952	23.809	37.142	44.761	31.428	37.777	62.856	58.094	53.333	58.094
1.0 %	31.428	29.523	10.476	23.809	42.856	45.714	14.285	34.285	75.237	78.094	25.714	59.682
2.0 %	33.333	24.762	2.857	20.317	50.476	41.904	6.667	33.015	86.665	68.570	14.285	56.507
3.0 %	32.380	22.857	0.952	18.730	44.761	37.142	2.857	28.253	77.142	55.237	4.762	45.714
4.0 %	24.762	20.000	0.000	14.921	38.094	34.285	0.000	24.126	54.285	40.951	0.952	32.063
5.0 %	20.952	16.190	0.000	12.381	26.666	21.905	0.000	16.190	36.190	29.523	0.000	21.904
6.0 %	14.285	11.428	0.000	8.571	19.048	15.238	0.000	11.428	25.714	20.952	0.000	15.555
7.0 %	6.666	4.762	0.000	3.809	12.380	7.619	0.000	6.666	19.048	16.190	0.000	11.746
Mean	23.174	19.259	6.032	16.155	33.439	30.899	9.418	24.585	54.073	46.349	16.508	38.977
SEm±	0.97	0.97	0.97	0.56	1.27	1.27	1.27	0.733	1.48	1.48	1.48	0.853
CD 5 %	2.75	2.75	2.75	1.588	3.6	3.6	3.6	2.079	4.19	4.19	4.19	2.419
Sugar medium (A)												
SEm±			0.323				0.493				0.493	
CD 5 %			0.9166				1.397				1.397	

Mean square of different days for spore germination

Source	d.f.	45th day	50th day	60th day
Between sugars (A)	2	2178.73**	4701.99**	10626.00**
Between concentrations (B)	8	422.091**	1059.63**	3248.73**
A x B	16	106.222**	224.927**	592.00**
Error	54	152.375	4.83762	6.55048

** Significant at 1 % level of significance

Germination was observed up to 7% concentration in sucrose and glucose, and up to 4% concentration in fructose. The highest percentage of spore germination was observed in sucrose at 2% (86.67), glucose at 1% (78.09), and fructose at 0.5% (53.33) concentration. Statistical analysis revealed significant differences between the various sugars and different concentrations. Additionally, according to (Fig.-1) the interaction between sugars and concentrations was also significant at all time periods.

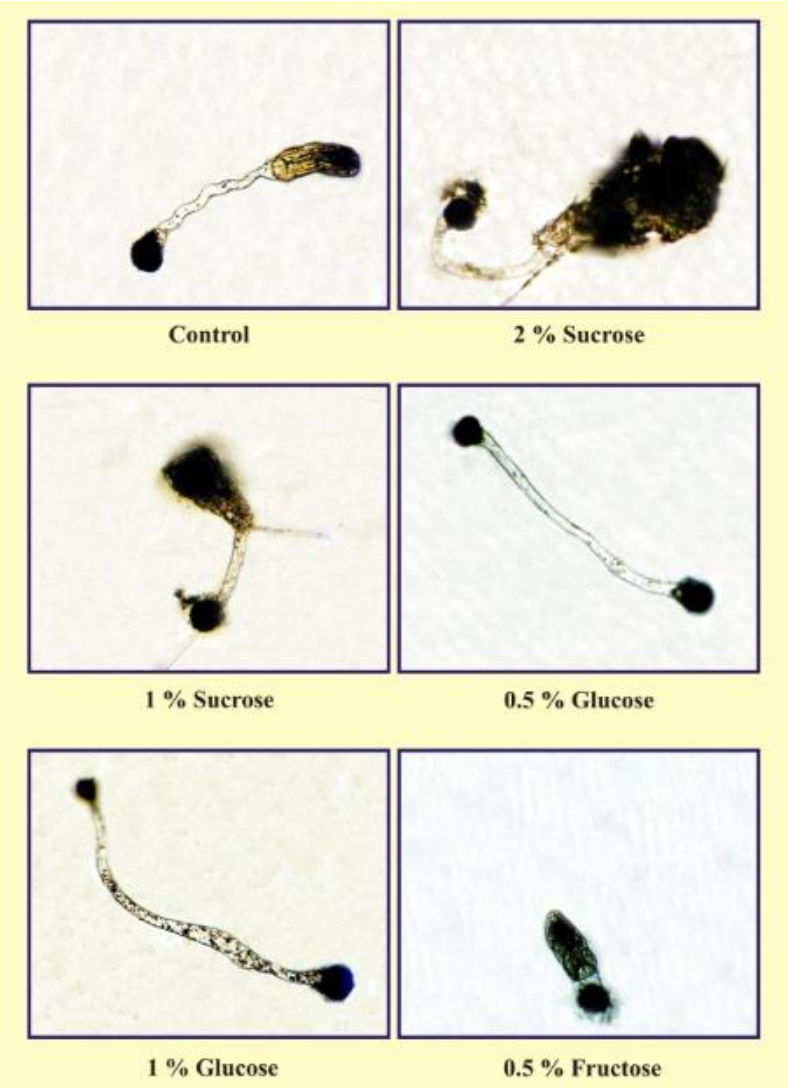

Figure 2: Effect of Sucrose, Glucose and Fructose on spore germination of *Riccia Gangetia*

Several scientists have documented that the inclusion of specific organic compounds, namely glucose, fructose, maltose or sucrose, into either distilled water or inorganic media triggers spore germination in some bryophytes[6,8], under dark conditions. However, Inoue[5] noticed that in several members of the Marchantiales, spores did not germinate when sugars were present in the culture media even under complete darkness.

In *Bartramia*, a minor impact of sugar on spore germination has been observed at concentrations ranging from 0.1 to 1.0 percent, with fructose and sarbose exhibiting a slightly greater effect at concentrations below one percent[7]. The current study indicates that the spores of *Riccia gangetica* failed to undergo germination in the absence of light due to the morphogenetic properties of light and its ability to aid in the utilization of exogenously supplied sugar. This outcome is consistent with the findings of Dua et al.[2] Similarly showed that the growth of *Riccia gangetica* is inhibited in the absence of light and in the presence of 1% sucrose. The findings of this inquiry on *R. gangetica* suggest that sucrose is the preferred source of carbohydrate for spore germination, followed by glucose and fructose. Additionally, it was observed that a higher concentration of sugars resulted in reduced spore germination due to the growth of fungi and bacteria in the cultures. The negative effect on the frequency of germination is most likely a consequence of this contamination.

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