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A review on Low cost micro propagation techniques in banana

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Abstract
Banana, an ancient fruit crop is known as 'apple of paradise' and is botanically named as *Musa paradisiaca*. It belongs to family Musaceae. Micro propagated banana plantlets are increasingly becoming the planting material of choice because of disease control, uniformity and the possibility of rapid multiplication. However, growers have to face higher costs and pay up to five times more than for suckers. The cost of fully hardened banana plantlet is Rs.10-12/plantlet while the cost of sucker derived banana is Rs. 2-3/plantlet. Small and marginal farmers cannot afford the micro propagated banana plantlets. A 90% resource cost reduction in tissue culture of banana was achieved by replacing tissue culture grade sucrose and Gelrite in the medium with locally available commercial sugar and a starch/Gelrite mixture or sago (39.39 % of agar cost), cotton fiber support (60.22 % of agar cost), Starches of corn or potato could partially substitute for Gelrite and agar. Sugars of cane or sugar beet origin were suitable. AR grade sucrose by rock sugar (95.85 % of sucrose cost) and distilled water by aquaguard water (89.60 % of double distilled water cost) and by using sun light instead of artificial light. Low cost options should lower the cost of production without compromising the quality of the micropropagules and plants. In low cost technology cost reduction is achieved by improving process efficiency and better utilization of resources. Low-cost tissue-culture technology is high priority in agriculture, horticulture, forestry, and floriculture of many developing countries for the production of suitably priced high quality planting material.

Keywords: Banana, Low cost techniques, Micro propagation

Introduction
Banana (*Musa* spp. L) is nutritionally significant, one of the most important food crops, which is cultivated in tropical and subtropical countries around the world. Conventionally, banana is grown through sword suckers produced from the mother plant. Banana plantlets raised through micro propagation remain always high in demand (Anonymous, 2005) [2]. This technique provides a large number of uniform, high quality and disease-free planting material to meet demand in a short span of time on a year-round basis anywhere, irrespective of the season and weather (Anonymous, 2004) [1].

Micro propagation is a vegetative propagation of plant under aseptic conditions. Very small explants can be used for micro propagation, which is impossible with conventional technique. It can be used to produce disease-free plants by excluding disease-causing organisms during the propagation cycle. The major advantage of micro propagation is the extremely high multiplication rates. Therefore, this technique is highly suited for rapid multiplication of rare genotypes.

Tissue culture plants are the major source of planting material, however the cost of production is higher than the conventional method of propagation by suckers in banana. In tissue culture industry the cost of media preparation (chemicals and carbon source) can account to 15-20 per cent and the cost of energy can account up to 60 per cent of the production cost (Prakash and Savangikar, 2002) [5]. Therefore, low cost alternatives are needed to reduce the production cost. The disadvantage of modern plant tissue culture methods is the relatively higher costs involved as compared to other methods. The need for low-cost plant tissue culture systems, applicable for micro propagation and *in vitro* conservation of plant genetic resources, has been emphasized to allow the large-scale application of such technology in developing countries.

The use of chemicals such as carbon sources, gelling agents, inorganic and organic supplements, and growth regulators in culture media, make this technique expensive. Sucrose is usually used as a source of carbon and agar as the gelling agent, and together they constitute the most expensive components of the culture media.

2. Low cost approaches

Micro propagation technology is more expensive than the conventional methods of plant propagation, and requires several types of skills. It is a capital-intensive industry, and in some cases the unit cost per plant becomes unaffordable. During the early years of the technology, there were difficulties in selling tissue culture products because the conventional planting material was much cheaper. Now this problem has been addressed by inventing reliable and cost effective tissue culture methods without compromising on quality. The cost of the medium per liter was worked out with modifications in its components (Savangikar, 2002) [7].

2.1 Alternatives to Carbon Sources

Sucrose is the most commonly used carbon source in the micro propagation of plants. Sucrose adds significantly to the media cost. Household sugar and other sugar (sugar cubes) sources can be used to reduce the cost of the medium (Thorpe, 2007) [9]. Sucrose made of cane sugar and contains 99.98% sucrose and 0.01% reducing sugar. Household sugar (crystalline sugar) made of cane syrup treated with SO_2 (sulfitation) or CO_2 (carbonation) and contain 96-97% sucrose and 0.75-1.0% reducing sugar. Sugar cubes made from grains of refined crystalline sugar, and contain 99.5% sucrose and 0.03% reducing sugar. It is considered to be higher quality than crystalline sugar (Tyagi *et al.*, 2007) [10].

Conventional sucrose | Table sugar | Sugarcane juice

2.2 Alternatives to Agar

Agar has been taken for gelling agent in tissue culture media as it is biologically inert and has high gel clarity, stability and resistance to digestion by plant enzymes. Moreover agar happens to be the most expensive constituent of plant tissue culture media followed by sucrose. In media preparation conventionally agar is used. Instead of that low cost alternatives are isabgoal or sago or corn starch and cassava starch is used.

Prakash (1993) [6] stated that gelling agent, agar which is usually added to increase media viscosity contributes 70% of the media costs. The high production costs in the micro propagation procedures can drastically be reduced if cheap and (or) reusable alternatives to highly expensive tissue culture grade purified agar could be employed without compromising the quality of regenerated plants.

The use of laundry starch, potato starch and semolina in a ratio of 2:1:1 reduced the cost of gelling agent by 70-82%. However, the addition of such gelling agents to the medium also has some disadvantages. Some gelling agents contain inhibitory substances that hinder morphogenesis and reduce the growth rate of cultures.

Gelling agent

Conventional agar-agar Isabgoal powder

Table 1: Cost of conventional and low cost alternative sources.

Sl. No	Conventional source	Low cost alternative source	Cost per kg		
			Conventional source	Alternative source	Total % of cost saving
1.	Sucrose	Sugar & sugarcane juice	1,000	40	96
2.	Agar	Isabgoal, sago, corn starch & cassava starch	4,000	300	92.5
3.	Sodium hypochlorite (4%)	Jik	1600	110	93
4.	Energy (growth room)	Natural light room	>60% of total cost of production	_	60

2.3 Alternatives to distilled water

Water is the main component of all plant tissue culture media. Usually in tissue culture research, distilled or doubled distilled and de-ionized water is used. Distilled water produced through electrical distillation is expensive. In some cases, alternative water sources can be used to lower the cost of the medium. Distilled water was replaced by tap autoclaved tap water. If tap water is free from heavy metals and contaminants, it can be substituted for distilled water (Sharifi *et al.*, 2010) [8].

3. Alternative to conventional equipments

An alternative to reduce the unit cost of tissue culture micro propagation, autoclave can be replaced by pressure cooker. Contamination was not observed when the media and equipment were sterilised using a pressure cooker instead of an autoclave. Culture bottles were also replaced by jam jars (Gitonga *et al.*, 2010) [3].

Table 1: Comparative costing of production of banana plantlets by traditional tissue culture and low cost procedure using a 1liter MS medium.

I	Cost of MS medium	Traditional (Rs)	Low cost(Rs)
a)	Initiation (500ml liquid medium)	11.18	11.18
b)	Initiation (1L semi- solid medium)	28.56	28.56
c)	Shoot multiplication	28.56	3.98
d)	*In vitro* rooting	27.84	4.13
e)	Double distilled water	41.12	3.50
II	**Cost of glass wares**		
a)	Test tubes (25 number)	25.00	25.00
b)	Baby jars (50 numbers)	26.66	26.66
c)	Glassware used for media preparation	15.00	15.00
III	**Electricity and labour cost**		
a)	Culture room	74.40	34.22
b)	Laminar air flow cabinet	79.89	79.89
c)	Autoclaving	201.00	201.00
d)	Labour	43.74	43.74
IV	**Weaning cost**	445.23	445.23
V	**Total cost (Rs)**	1048.18	922.00
VI	**Number of plantlets produced**	300.00	375.00
VII	**Cost per plantlet (Rs.)**	3.49	2.45

Prabhuling *et al*. (2010) [4] studied and reported the comparative cost of banana plantlets, in traditional tissue culture it takes Rs.3.49 per plantlet and in low cost alternatives it takes around Rs.2.45 per plantlet. Using locally available materials natural and are best option for low cost tissue culture technology.

Conclusion

The above research findings had showed that use of locally available equipments like pressure cooker, plastic syringes, jam bottles office waste papers and shade net, these are the low cost alternatives for equipments and the total per cent of cost saving is 93.3. Use of some alternative mineral salts, vitamin tablets, commercial grade sugar or sugarcane juice and sago or isabgoal or cassava starch for media and the total per cent of cost saving 95. The using of natural light *i.e*. solatube room or tubular skylight; it reduces the 60 per cent of the total electricity bill. These techniques are very easy and useful to small scale tissue culture industry. These low cost alternatives are locally and cheaply available materials. Therefore, low cost alternatives are needed to reduce the production cost.

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