The Role of in Vintro Culture to Support Sustainable Agriculture and Agroindustry

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Abstract. Various plants grown on land have been widely used to support sustainable agriculture and in various industries, including to produce medicines, beauty ingredients, food and beverage ingredients, biofuels, bioenergy, land conservation, produce early stress-resistant varieties, and plant breeding. The problem of this article is that it takes a long time to harvest plants from the land, depending on the physiology and the plants harvest age. The problems that have been described could be overcome with *in vitro* culture techniques that could support industrial needs and sustainable agriculture. The purpose of this article is to study *in vitro* culture techniques of plant that could be implemented in agroindustry and support sustainable agriculture. The methodology used was a literature study related to the *in vitro* culture implementation of plant in agro-industry and sustainable agricultural development. The result of this writing is that *in vitro* culture of plant could support agroindustry, as one example is the acquisition of *catechins* secondary metabolites from the *in vitro* technique of *Camellia sinensis* L plants which are useful in the pharmaceutical industry. Furthermore, this article also showed that *in vitro* culture also supports sustainable agriculture, including in producing plant varieties that are resistant to stress which could be implemented in sustainable agriculture. The conclusion of this article is that *in vitro* culture is a technique that strongly supports sustainable agriculture and supports agro-industry .

Keywords: Agroindustry · Catechins · Plant in vitro culture · Sustainable Agriculture

1 Introduction

The role of *in vitro* culture of plants strongly supports sustainable agriculture. The essence of sustainable agricultural development is to combine social, cultural, economic and ecology whose implementation is multidimensional, multidisciplinary integrated at the regional to the central level [1]. Implementation of *in vitro* culture in sustainable agriculture including the formation of plants that are resistant to drought so that it can improve ecology, plant products with evidence that will support the economy of

R. F. Setiawan et al. (Eds.): ICA 2022, ABSR 33, pp. 215–219, 2023.
https://doi.org/10.2991/978-94-6463-168-5_23

farmers. As a social vehicle related to increasing human resources by holding training to improve plant natural resource products. The role of cultural in vitro plants in addition to supporting sustainable agriculture is also very influential on various agroindustry. The results of the study used the in vitro culture method of Camellia Sinensis L. plant produced by secondary metabolites catechin which has the potential to support health agroindustry has been obtained [2]. In vitro culture research conducted [3] has succeeded in making oil palm clones superior with productivity each hectare which reaches more than 30%. Cultivation of rubber plants through *in vitro* culture has been produced by the same rubber seeds that can support various Industry [4]. The role of *in vitro* culture is very necessary not only for sustainable agriculture but also in various agroindustries. The purpose of this article is to study the technique of *in vitro* culture of plants that can support agroindustry and support sustainable agriculture.

2 Research Methodology

The methodology used is a literature study method related to the implementation of *in vitro* culture of plants in agroindustry and in sustainable agricultural development.

2.1 In Vitro Culture

In vitro culture techniques must be carried out asepticly with phasing including: preparation of nutritional media, explants inoculation, aseptic cultivation, aseptic culture manufacturing, callus initiation, multiplication of shoots, induction of roots and acclimatization [5].

The preparation of nutritional media is the initial activity that must be observed. The composition of the media can contain: 1) Macro mineral salts concentrate with optimum greater than 0.5 micromol per liter, while micro minerals with optimum concentrations are less than 0.5 micromol per liter. 2) Carbon/macro element with a concentration greater than 0.5 mmol/L. If this concentration is optimum, the cultural growth rate will be maximum. 3) Vitamins that can increase cell growth, 4) organic supplements and 5) growth regulators.

Explant inoculation is carried out by considering the physiological age of explants in young tissue that is actively growing so that the cells are actively dividing and relatively containing a little contaminant. Explants taken from old mothers even though they are sacrificed from a tissue that is physiologically still young, the results are also less than optimal.

Aseptic cultivation means that all materials, equipment, rooms, human resources must always be maintained sterile which are free from microorganisms.

Callus initiation, starting with planting explants in a particular media to grow callus. The callus that formed as an initial basic ingredient for further development according to the purpose of the study/as a biomass to identify the content of secondary metabolites.

Shoots multiplication, is a propagation of shoots resulting from callus initiation in a medium that is enriched with cytokinin growth regulators (Benzylamino Purines, Kinetin) which can stimulate the growth of shoots. The use of growth regulators generally

Table 1. Examples of Plants that are Resistant to Ecological Changes and Increased Production of Secondary Metabolites

Plant Species	Plant growth regulator	Secondary metabolite	Culture in vitro
Psoralea cordifolia	MS + TDZ + BA	Isoflavones	Cell Suspensions
Vitis vinifera	MS + IAA + GA3 + UV	Resveratol	Cell Suspensions
Azadirachta indica	MS + 2,4-D	Azadirachtin	Cell Suspensions
Catharanthus roseus	MS + 2,4-D + UV-B	Catharantine	Cell Suspensions
Raulvolfia	MS + BAP + IAA	Serpentine	Cell Suspensions

Source: [12]

uses auxin and cytokinin ratios that are adapted to the characters of the plant that will be cultured.

Induction of roots to grow roots using half of the MS medium without adding growth regulators, but each plant generally requires more specific auxin and cytokinin ratios.

Acclimatization is the process by which an individual organism adapts to changes in its environment. This adjustment requires stages so that plants can adapt from high air humidity to low air humidity which then becomes plant seeds according to user needs.

2.2 Potential of in Vitro Culture in Sustainable Agriculture

Sustainable agriculture is based on three dimensions: economic, social, and ecological [6]. Ecological dimensions of sustainable agriculture such as cultivating crops with various varieties such as planting trees, grasses that can increase the population of beneficial insects that can minimize extreme conditions of climate change [7].

The potential of in vitro culture in sustainable agriculture includes the formation of plant varieties that are resistant to ecological changes as a result of extreme climate change. Research conducted [8] on tomato plants that are resistant to salinity and ecological changes due to temperature stress caused by administration of jasmonic acid through in vitro culture can increase polyphenol levels. Some examples of in vitro cultured plants that are resistant to ecological changes such as stress to increasing air temperature also increase the production of secondary metabolites are listed in Table 1.

2.3 The Role of in Vitro Culture in the Field of Cosmetic – Health Agroindustry

The role of in vitro culture in the field of Cosmetics - Health Agroindustry can produce secondary metabolites according to industrial needs as shown in Table 2.

Table 2. The role of in vitro culture in the field of Health-Cosmetic Agroindustry can produce secondary metabolites

Market Names of Active Ingredient	Plant Species	Type of cell culture and Extracts	Benefs	Compy; Country
Phyto-Biotics Perilla®	Perilla frutescens	cell suspensionex ract	anti-aging,	Active Concepts LLC; USA
Phyto-Biotics Quercus®	Quercus alba	stem cellsextract	antioxidant,	Active Concepts LLC; USA
Phyto-Biotics Acai®	Euterpeoleracea	cell suspensionextract	anti- wrinkle	Active Concepts LLC; USA
Akosky® apium	Apium graveolens	callus cultuextract	skin regeneration	Akott Evolution S.R.L.; Italy
VITADENIA®	Gardenia taitensis	callus cultuextract	regenerative	Biocosmethic; France
UrbanEthic®	Gossypiumherbacm	stem cell extrat	anti-photo-aging,	Biocosmethic; France

Source: [13]

3 Results and Discussion

The role of in vitro culture to support sustainable agriculture is that this technique can overcome/accommodate by producing plants that are resistant to ecological changes. In addition to being resistant to ecological changes, plants also produce secondary metabolites. The role of *in vitro* culture to support agroindustry is that it can be applied to the health cosmetic industry. Some examples of *in vitro* culture of plants producing health cosmetic ingredients include on plant culture: Perilla frutescens, Quercus alba, Euterpeoleracea, Apium graveolens, Gardenia taitensis, Gossypiumherbacem. The writing of this article is relevant to the research of [9] which produces epicathecin secondary metabolites that have potential for the health sector. In addition, its productivity and health maintenance properties are similar to its parent plant, and it has an important role in maintaining plant health through dimensions such as genetic engineering, breeding and afforestation [10].

4 Conclusion

In vitro plant culture is an ideal technique because from a sustainable agriculture perspective it can reduce the impact of ecological changes. In vitro plant culture can also be applied to various agro-industries, including the health-cosmetic industry.

References

1. Rudy SR. dan Iwan SA.: Concept and Implementation of Sustainable Agricultural Development in Indonesia. (2011)
2. Sutini, Widiwurjani, Ardianto C., Khotib J., Djoko AP., Muslihatin M.: Production of the secondary metabolite catechin by in vitro cultures of Camellia sinensis L. Journal of Basic and Clinical Physiology and Pharmacology, (6)1–7 (2020).
3. Dian RP., Wening S., Supena N., Retno DS., Yenni Y.: Oil palm tissue culture: Challenges and opportunities. Warta PPKS, 5(1) 1-10 (2020).
4. Sutini, Widiwurjani, Augustien N., Suhardjono, Guniarti, Djoko AP., Muslihatin M.: In vitro culture technique of Camellia sinensis L for epicatechin production with phosphor inducer. Journal of Biological researches, 25(2) 27–31 (2020).
5. Sulistiani E.: Stages of Micropropagation for the Propagation of Seameo Biotrop Plant Seeds. Southeast Asian Regional Center for Tropical Biology (2021).
6. Anonimous. :The Definition and Concept of Sustainable Agriculture. Department of Agriculture District. Buleleng (2019).
7. Pedrazani H, Racagni G, Alemano S, Miersch O, Ramirez I, Pena-Cortes H.:Salt tolerant tomato plants show increased levels of jasmonic acid. Plant Growth Regul, (412)149–58. (2003).
8. Akula R & Gokare AR.: Influence of abiotic stress signals on secondary metabolites in plants. Plant Signaling & Behavior, 6 (11) 1720–1731(2011).
9. GeorgievV, Slavov A., Vasileva I., PavlovA.: Plant Cell Culture as Emerging Technology for Production of Active Cosmetic Ingredients. Laboratory of Applied Biotechnology - Plovdiv, The Stephan Angeloff Institute of Microbiology, Bulgarian Academy of Sciences, Plovdiv, Bulgaria (2018).
10. Shashank MP, V.B Chandana Kumari, K.Sumana, S.Sujay, M.Tejaswini, Prithvi SS, and Ramith R: Sustainable Development of Plant Tissue Culture Industry: The Indian Scenario. Journal of Applied Biology & Biotechnology, 9(2) 18–27(2021).