DIRECT PLANT PRODUCTION FROM THE AUXILIARY BUD IN YACON (*SMALLANTHUS SONCHIFOLIUS*) IN THE FIELD CONDITION

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Abstract

The direct plant production from the axial bud was established in the field condition in in yacon (*Smallanthus sonchifolius*) for the first time. The fructo-oligosaccharides (FOS), an active component which was enriched in tuber had health benefits. The FOS could potentially reduce glycemic index, body weight, the risk of colon cancer, the control of blood sugar levels, control of cholesterol level including boost up immune system and helping in weight loss. This perennial herbaceous plant, belongs to the family *Asteraceae* was propagated by corms. But the corm production was not fast and easy enough to meet the growing need for QPM. Yacón was also propagated from stem cutting. But the stem cutting destroyed the mother plant. Hence, alternative but efficient propagation technique like direct organogenesis from stem explant and leaf segments was reported through tissue culture which required sophisticated environment. In addition, somatic embryogenesis was also reported through tissue culture recently. Characteristically, a full grown yacon at lower altitude produced 40.51±4.51 axial bud in the Terai zone. The axial bud could be potentially explored for the novel method of QPM production as well as establishment of new plant in the field condition directly in a very low-cost way without destroying the mother plant as well. Moreover, a continuous and exponential process of propagation could be achieved without destroying the mother plant. To the best of our knowledge, the production of QPM from axillary bud is being reported for the first time directly in the field condition in a very simple way.

Key words : *Smallanthus sonchifolius*; Auxiliary bud; Quality planting material (QPM); Field condition.

Introduction

Yacon (*Smallanthus sonchifolius*) was a perennial herbaceous plant from the family *Asteraceae*. Yacon tuber had a medicinal value as it was enriched with fructo-oligosacharides (FOS) which constituted 6.4% to 70% of the dry matter and 0.7% to 13.2% of the fresh weight. The active component, FOS offered an excellent health benefits like reduced glycemic index, body weight, the risk of colon cancer, the control of blood sugar levels, control of cholesterol level, boosting immune system and helping in weight loss. With the increasing demand for yacon in the market due to its medicinal properties, farmers demand for sufficient quality planting material (QPM). Therefore, a better, convenient and effective ways to achieve mass clonal propagation was a relevant issue. Normally, yacon was conventionally propagated by the propagating roots (corms) but corm production was not fast and easy enough to meet the growing need for good planting materials. The reduced flowering emergence as well as subsequent fruit set in the cultivated yacon were common problem in cultivated *Smallanthus* species (Leon., 1964). Moreover, high proportion of the seeds were also non-viable and/or low vigor. Aerial stem cuttings were also reported for its propagation conditioned with desiccation protection (Robinson, 1978; Castañeto and Inhumang, 2004). But this process needs the destruction of the mother plant. As alternative for multiplication and maintenance of germplasm of this species, efficient in vitro techniques have already been reported (Corrêa et al., 2009). Direct organogenesis from stem cuttings and leaf segments had been reported as a tool for germplasm conservation (Estrella and Lazart, 1994; Niwa, 2002). Even, somatic embryogenesis was developed for this species (Corrêa et al., 2009). The present innovation identified a very simple, low-cost process for clonal propagation in the field condition from the auxiliary bud is being reported for the first time. The innovation could be adopted as such by the farmers or growers or entrepreneurs directly without need any costly establishment.

Material and methods

Field experimental location and mother plant : The yacon plant was planted in first week of November and maintained in the field located at 28°19'N latitude and 89°23'E longitude and at an altitude of 43 m above the mean sea level. The plant was sown in ridge valley to avoid any excess water. The growing plant characteristically produced axial buds which were explored for new plant.

Harvesting the axial bud : The axial bud was harvested periodically as mother plant produced it continuously. The axial bud having two nodes will be considered for the QPM production.

Treatment of axial bud : The axial bud was harvested from the growing plant and touch with auxin enriched power (cutting aid).

Initial environment in the filed condition : The initial environment was crucial for root initiation. The axial bud was sensitive to humidity shock, therefore initial humid environment maintenance was mandatory for survival in the field condition. The transparent plastic cup was used for this purpose. During planting the axial bus, watering followed by covering with plastic cup was maintained.

Figure 1. The process for QPM production directly at field condition. The harvested axial bud was touched with toto-root powder at the cut end and incubation of planted axial plant in humid condition in transparent box for 14 days. The cup was removed and allowed to grow without cup.

Discussion

Tuber corm was explored for the QPM production in yacon. The process for QPM was not sufficient for fulfilling the demand. QPM production was evidenced from hormone supplemented MS media from explant. In addition to all, a new process for QPM production is being reported for the first time in a very convenient way in the filed condition. The steps for achieving the new plant regeneration from axial bud from the existing plant directly on soil through treatment of hormone, moist soil and using transparent plastic cup. First of all, the axial bud having minimum two nodes were harvested by cutting with knife. The cut end of the axial bud touched with the auxin enriched powder (**Figure 1**). The auxin enriched powder treated axial bud was transplanted into field directly (**Figure 1)**. The transparent plastic cup was used to cover the transplanted axial bud (**Figure 2**). After 14 days later, the plastic cup was removed. The 42 days plant was snapshotted (**Figure 4**) and very importantly, all the plant was survived.

Figure 2 : Close and field view of assembly of planted axial bud.

Experiment was carried out to evaluate the merit of auxin enriched powder in initiating root development (**Figure 3**). The axial bud without auxin enriched power was considered for this experiment. From the result, it was evidenced that auxin enriched power induced root initiation from nodal region of the axial bud (**Figure 3**). The auxin enriched powder induced visually higher number of root development from nodal region of the axial bud (**Figure 3**).

+ cutting aid - Cutting aid

Figure 3 : Rooting in axial bud in the field condition directly exploring the auxin hormone. The 14 days axial bud showed rooting emerged from nodal region whereas the axial bud without auxin supplementation showed poor rooting.

The cutting aid was enriched with IBA, NAA, PHB, H_3BO_3, Vitamin, Surfactant, Talc power. The direct power was used for the study for root initiation in the field condition. Characteristically, it was found that root was initiated in a better way from the nodal region in the humid region maintained in the plastic cup. The experiment was performed in the cool environment in the terai zone but no experiment was performed in the summer period or other time point in the year. The survived plant also contributed axial bud which was again explored for QPM production. As it was perennial crop, a model was developed for continuous and exponential rate of QPM production from auxiliary bud in yacon (*Smallanthus sonchifolius*) directly in field condition in a very low-cost way throughout the growing period (**Figure 5**) if the plant was survived in the Terai zone as the experimental result was presented only a short period of time only covering the winter season. The mother plant contributed axial bud which was explored for new QPM production. The new QPM will again contributing new axial bud including mother plant. hence, the process will be continued and exponential rate of QPM could be possible in the field condition directly without any requirement of sophisticated process which required huge investment.

Figure 4 : Established plant from axial bud in the field condition

Yacón, *Smallanthus sonchifolius* was a member of *Asteraceae* family and originated in the mountain regions of South America. It is a perennial herb, 2 to 2.5 m tall with a root system composed of 4 to 20 edible fleshy tuberous storage roots (Zardini, 1991). This species has received attention due to enrichment of fructo-oligosaccharides in its roots. It was a relatively low energy value despite its juiciness and sweet taste (Aybar et al., 2001). Medicinally, yacón has been used as an auxiliary in the treatment of diabetes and digestive disorders. Aybar et al. (2001) demonstrated the hypoglycemic effect of the aqueous extract of yacón leaves in diabetic rats produced an increase in the concentration of plasma insulin. Recently, analysis of the leaf and tuber extracts showed that both parts of the yacón plant represented a rich source of phenolic acids and other radical scavenging compounds, suggesting antioxidant proprieties (Valentova et al., 2005). Yacón is propagated from offset, stem cutting and tuber division (Grau and Rea, 1997). As alternative for multiplication and maintenance of germplasm of this species, efficient in vitro techniques have become necessary. Direct organogenesis from stem cuttings and leaf segments has been reported as a tool for germplasm conservation (Estrella and Lazart, 1994; Niwa, 2002). Even, somatic embryogenesis reported for this species. In the present study, QPM production from axial bud was directly developed in the filed condition. As it was perennial herb, the process could be followed throughout the year. This is the first report of producing QPM from axial bud in the filed condition in a very low-cost way.

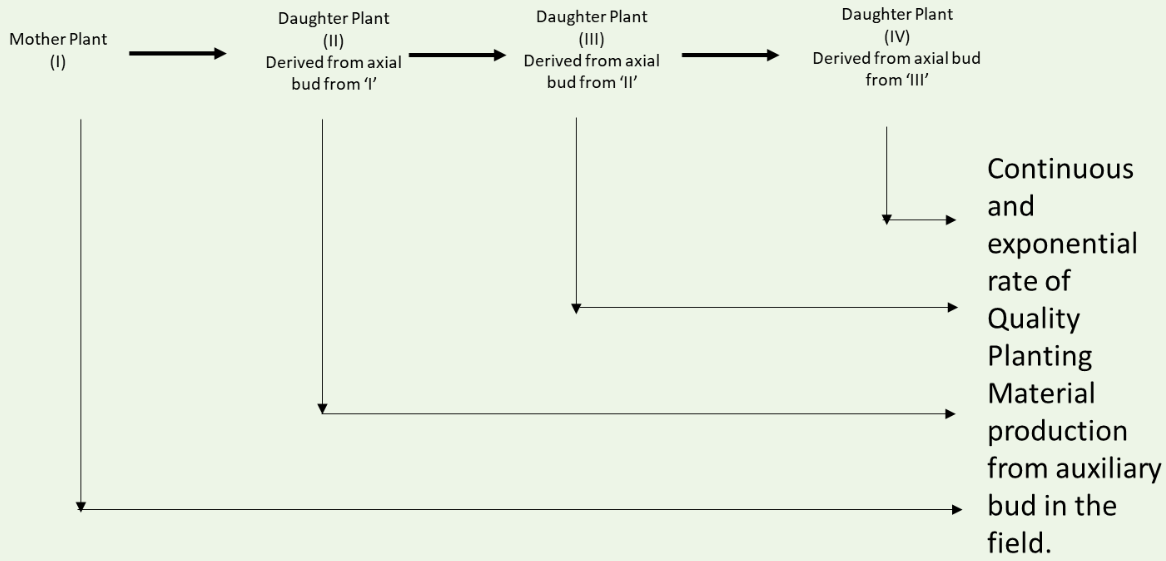

Figure 5. Model for continuous and exponential rate of Quality Planting Material production from auxiliary bud in yacon (*Smallanthus sonchifolius*) directly in field condition in a very low-cost way throughout the growing period.

Author contribution statement : HAM conceptualized the idea, performed the experiment and wrote the manuscript. BP performed experiments. SSS and MM also involved in experiments.

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References

Angayon, JD., Castañeto, Y.T., and Castañeto, ET (2008). Rooting of Yacon (*Smallanthus sonchifolius*) Using Main Stem in Different Rooting Media. NVSU Research Journal Vol. XV Nos. 1&2 Jan. - Dec. 2008.

Aybar, M. J.; Riera, A. N.S.; Grau, A. and Sanchez, S.S. (2001), Hypoglycemic effect of the water extract of Smallanthus sonchifolius (yacón) leaves in normal and diabetic rats. J. Ethnopharmacol., 74, 125-132.

Castañeto, Y. T. and Inhumang, I. A. 2004. Rooting of ipil (*Intsia bijuga* Colebr.) cuttings from seedlings using indolebutyric acid (IBA). Meristem. Vol. 4: 9-12.

Corrêa, C.M., De Oliveira, G.N., Astarita, L.V., and Santarém, E.R. (2009). Plant Regeneration through Somatic Embryogenesis of Yacón [Smallanthus sonchifolius (Poepp. and Endl.) H. Robinson]. Braz. Arch. Biol. Technol. v.52 n.3: pp. 549-554, May/June 2009.

Estrella, J. E. and Lazart, J. E. (1994), In vitro propagation of jicama (Polymnia sonchifolius Poepp. and Endlicher): A neglected Andean crop. HortScience, 29, 331.

Grau, A. and Rea, J. (1997), Yacon, Smallanthus sonchifolius (Poepp. and Endl.) H. Robinson. In: Andean roots and tubers: Ahipa, arracacha, maca yacon. Promoting the conservation and use of underutilized and neglected crops, eds. M. Hermann and, J. Heller. Gatersieben/International Plant Genetic Resources Institute. Rome, pp. 199-242. Available at: http://www.cipotato.org/artc/yacon.asp Accessed at Apr, 27th, 2007.

Leon, J. 1964. Plantas alimenticias andinas. Boletin Teenico No. 6II CA, Lima, Peru

National Research Council. 1989. Lost crops of the Incas: Little-known plants of the Andes with promise for worldwide cultivation. Washington, DC: National Academy Press.

Niwa, M. (2002), Plant regeneration through leaf culture of yacon. J. Japan. Soc. Hort. Sci., 71, 561-567.

Robinson, H. 1978. Studies in the *Heliantheae* (Astereceae). XII. Re-establishment of the genus Smallanthus. Phytologia 39 (1):47-53.

Valentova, K.; Moncion, A.; de Waziers, I. and Ulrichova, J (2005), The effect of Smallanthus sonchifolius leaf extracts on rat hepatic metabolism. Cell Biol. Toxicol., 20, 109-120.

Zardini, E. (1991), Ethnobotanical notes on yacón, Polymnia sonchifolia (Asteraceae). Econ. Bot., 45, 72-85.