

RESEARCH ARTICLE

CHANGES IN SELECTED BIOCHEMICAL COMPOUND CONTENTS AND ENZYMATIC ACTIVITIES DURING VIVO-PLANT PRODUCTION IN PLANTAIN (*MUSA AAB*) CV. 'CORNE 1'

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Abstract: The limited availability of high-quality planting material is one of the major constraints to increasing plantain production in Côte d'Ivoire. Macropropagation represents an accessible alternative for the rapid production of planting material; however, the biochemical and enzymatic processes associated with bud formation remain poorly documented. This study evaluated the effect of prior sucker dehydration on bud production and characterized changes in selected biochemical compounds and enzymatic activities during macropropagation of the plantain (*Musa AAB*) cv. 'Corne 1'. A total of 90 suckers were collected, and healthy suckers were assigned to two treatments: non-dehydrated suckers (TEM) and suckers dehydrated for two weeks (DESH). Total sugar, total protein, and total phenolic compound contents, as well as phenylalanine ammonia-lyase (PAL) and peroxidase (POX) activities, were determined weekly over a six-week incubation period. The first roots emerged after 7–8 days, whereas the first buds were observed after 14 days. The mean number of buds per explant was significantly higher in DESH (58.28 buds) than in TEM (34.66 buds). In contrast, the mean times to root emergence and bud emergence did not differ significantly between treatments. Total sugar, protein, and phenolic compound contents, as well as PAL and POX activities, showed temporal variations that differed between treatments. These results indicate that prior dehydration for two weeks can enhance bud production and is associated with changes in the biochemical and enzymatic dynamics of suckers during plantain macropropagation.

Keywords: Plantain, *Musa AAB*, Macropropagation, Sucker dehydration, Bud production, Biochemical changes

INTRODUCTION

Plantain is the fourth most important food crop produced in Côte d'Ivoire, after yam, cassava, and rice. With an annual production of approximately 1.6 million tonnes, Côte d'Ivoire is the third-largest supplier of plantain in West Africa. However, this production remains insufficient to meet the continuously increasing demand resulting from rapid population growth and the quantities exported to neighboring countries and Europe. The capacity of production systems to meet this growing demand remains uncertain, particularly due to pest and disease pressure and, above all, the insufficient availability of high-quality planting material.

To overcome these constraints, several propagation approaches have been developed to facilitate the large-scale production of planting material and contribute to improving plantain production. These approaches include in situ methods (Bonte et al.,

1995), macropropagation methods (Koné *et al.*, 2016), and in vitro techniques (Shirani *et al.*, 2009). Among these approaches, macropropagation is particularly attractive because of its relatively low production cost and its potential for implementation by farmers compared with in vitro techniques. Previous studies on plantain macropropagation have mainly focused on production performance as affected by substrate type, sucker size, and the physiological stage of the suckers (Koné et al., 2016), as well as on the conditions required for the acclimatization and hardening of vivo-plants (Koua, 2014). Other studies have investigated the effects of sucker dehydration on the mass propagation of vivo-plants.

Although these agronomic and technical studies have contributed to improving the production of vivo-plants, the physiological processes underlying their formation remain poorly understood. In particular, little information is available on the biochemical and

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enzymatic changes occurring during the transition from a sucker or stem fragment to newly formed buds and developing *vivo*-plants. The formation of new organs involves profound physiological changes that require the mobilization and synthesis of structural and reserve compounds, as well as the regulation of enzymatic activities. Understanding these changes could therefore provide useful information for elucidating the physiological basis of plantain *vivo*-plant production and potentially identifying biochemical indicators associated with successful bud initiation and *vivo*-plant development. To our knowledge, no study has specifically characterized the dynamics of biochemical compounds and enzymatic activities during the formation of *vivo*-plants from plantain suckers. The available literature provides only limited information on the biochemical mechanisms occurring within plantain suckers during the processes leading to bud emergence and *vivo*-plant formation. This knowledge gap limits our understanding of the biological mechanisms underlying *vivo*-plant production and may constrain the optimization of production conditions.

The present study therefore aimed to investigate changes in selected biochemical compounds and enzymatic activities during the production of *vivo*-plants from suckers of the plantain ‘Corne 1’ cultivar. The study was based on the hypothesis that bud initiation and subsequent *vivo*-plant development are accompanied by characteristic changes in biochemical compounds and enzymatic activities reflecting the physiological processes involved in *vivo*-plant formation. Specifically, the objectives were to: (i) stimulate bud production from

sucker stem fragments; (ii) quantify selected biochemical compounds at different stages of *vivo*-plant production; and (iii) evaluate changes in enzymatic activities throughout the *vivo*-plant production process.

MATERIALS AND METHODS

Study site

The study was conducted at the Laboratory of Biology and Improvement of Plant Production (LBAPV), Nangui ABROGOUA University, Abidjan, Côte d’Ivoire. The experimental site is located between 5°17’ and 5°31’ N latitude and 3°45’ and 4°22’ W longitude. The study area is characterized by a deep sandy-clay soil and a humid tropical climate, with a mean annual temperature of approximately 27 °C. The suckers used as plant material were collected from the experimental plot of the LBAPV, while the different stages of macropropagation and *vivo*-plant production were conducted in the laboratory’s experimental facilities.

MATERIALS

Plant material

The plant material consisted of suckers of the ‘Corne 1’ cultivar (Figure 1), which were collected from the experimental plot of the Laboratory of Biology and Improvement of Plant Production (LBAPV), Nangui ABROGOUA University. The ‘Corne 1’ cultivar has a production cycle of 10–11 months. The average bunch weight ranges from 9 to 13 kg, and each bunch bears an average of 4–6 hands with large fruits (Boyé *et al.*, 2010).



Figure 1. Suckers of the ‘Corne 1’ cultivar used as plant material in the experiment

Infrastructure and equipment

The infrastructure and equipment used for macropropagation included a plastic film-covered propagation chamber used for establishing the explants in a sawdust-based substrate, a mini-

greenhouse covered with palm-leaf shade, used for the acclimatization and hardening of the *vivo*-plants, and a shade structure used for the subsequent growth and development of the *vivo*-plants.

METHODS

Collection and dehydration of suckers

Suckers measuring 15–50 cm in height, measured from the soil surface, and weighing 500 g to 1 kg were collected using a palm-tree knife. A total of 90 suckers were collected. Following an assessment of their sanitary condition, only healthy suckers were selected for the experiment, whereas suckers showing signs of contamination were discarded. The selected healthy suckers were washed with tap water to remove soil particles adhering to their surfaces. They were then divided into two groups according to the duration before placement in the propagation chamber: a dehydration group and a control group. Suckers assigned to the dehydration group were kept under shelter and exposed to ambient air for two weeks, under conditions that protected them from rainfall and direct sunlight. Suckers in the control group were used on the day of collection, without prior dehydration.

Preparation and establishment of explants in the propagation chamber

The suckers were peeled and trimmed to expose the inner tissues, and were then immersed for 15 min in a solution containing a mixture of Furadan 5G (15 g/L) and mancozeb 880 W (15 g/L). After soaking, the pre-explants, consisting of peeled and trimmed suckers, were removed from the solution and dried under shelter for 48 h. At the end of this period, the surface of the pseudostem was freshly trimmed. Two perpendicular incisions were then made at the center of each explant to induce stress to the apical meristem and promote bud emergence. The prepared explants were placed in a propagation chamber containing sawdust as the substrate. Twenty-four hours after the explants were placed in the propagation chamber, the substrate was thoroughly watered. Thereafter, watering was carried out two to three times per week, depending on the moisture status of the substrate.

The mean time to root emergence, mean time to bud emergence, and mean number of buds produced per explant were determined during the *vivo*-plant production process.

Biochemical and enzymatic assays

The analyses included the determination of total sugar, protein, and phenolic compound contents, as well as the assessment of phenylalanine ammonia-lyase (PAL) and peroxidase (POX) activities, two groups of enzymes notably involved in phenolic compound metabolism. The samples were removed from the freezer and immediately used for the respective assays. The analyses were performed on non-dehydrated suckers (controls) and suckers dehydrated for two weeks.

Extraction and determination of total sugars

A 0.5-g sample of fresh tissue was ground in 10 mL of 80% ethanol. The homogenate was centrifuged at 5,000 rpm for 5 min. The resulting pellet was then

resuspended in 10 mL of 80% ethanol and centrifuged under the same conditions. The supernatants obtained from the two centrifugation steps were combined and adjusted to a final volume of 30 mL with 50% ethanol. The resulting extract was used for the determination of total sugars. Total sugars were extracted and quantified using the phenol–sulfuric acid colorimetric method described by Dubois et al. (1956).

Extraction and determination of proteins

A 0.5-g sample of fresh tissue was ground in 10 mL of 0.1 M sodium phosphate buffer (pH 7.5) in the presence of polyvinylpyrrolidone (PVP). The resulting homogenate was centrifuged at 5,000 rpm for 20 min. The resulting supernatant constituted the protein extract used for the assay. Protein content was determined according to the method described by Bradford (1976).

Extraction and determination of phenolic compounds

Phenolic compounds were determined with modifications and adaptations to the plant material used in this study. The method is based on the reduction, under alkaline conditions, of the phosphomolybdic and phosphotungstic acids in the Folin–Ciocalteu reagent by phenolic compounds, resulting in the development of a measurable color. For the assay, 0.5 mL of extract was mixed with 0.5 mL of 0.5 N Folin–Ciocalteu reagent and 2 mL of 17% sodium carbonate (Na_2CO_3) solution. The remaining reaction conditions and spectrophotometric measurement parameters, including the final reaction volume, incubation time, and wavelength, should be specified according to the protocol actually used.

Enzyme extraction and activity assays

Enzyme extraction

Enzymes were extracted under cold conditions using an extraction buffer appropriate for each enzyme. A 0.5-g sample of fresh tissue was ground in the corresponding extraction buffer. During grinding, polyvinylpyrrolidone (PVP) and polyethylene glycol (PEG) were added to the extraction medium to minimize interactions between phenolic compounds and enzyme proteins. β -Mercaptoethanol was also added to limit oxidation. Sodium thiosulfate and glycerol were added to the extraction medium to contribute to enzyme stabilization and protection.

Preparation of the purified enzyme extract

The enzyme extract was subjected to a purification step using DOWEX 2, an anion-exchange resin. The resin was homogenized with the enzyme extract, and the mixture was then incubated under cold conditions for 30 min. The mixture was subsequently centrifuged at 5,000 rpm for 10 min. The resulting supernatant constituted the purified enzyme extract, which was used for the determination of enzyme activities.

Phenylalanine ammonia-lyase (PAL) activity

Phenylalanine ammonia-lyase (PAL) activity was determined according to the method described by Zucker (1965), with modifications and adaptations to the plant material used in this study. The extraction buffer consisted of 0.1 M sodium phosphate buffer (pH 7.5). Following centrifugation of the homogenate, the resulting supernatant was subjected to purification using DOWEX 2 according to the procedure described above. The supernatant obtained after this purification step constituted the purified enzyme extract used to determine PAL activity.

Peroxidase activity

Peroxidase activity was determined according to the method described by Santimone (1973). Sodium phosphate buffer (0.1 M, pH 7.5) was used as the extraction buffer. Following centrifugation of the homogenate, the resulting supernatant was subjected to purification using DOWEX 2 according to the procedure described above. The supernatant obtained after this purification step constituted the purified enzyme extract used to determine peroxidase activity.

Parameters evaluated

The parameters evaluated during the vivo-plant production process were the time to root emergence (TAR), time to bud emergence (TAB), and mean number of buds produced (NBP).

The time to root emergence (TAR) was defined as the time required for the first root to emerge after the explant was placed in the propagation chamber. It was calculated as the ratio of the sum of the times required for root emergence to the total number of explants that produced roots.

$$\text{TAR} = \frac{\text{Sum of the times required for root emergence}}{\text{Total number of explants that produced roots}}$$

The time to bud emergence (TAB) was defined as the time required for the first bud to emerge after the explant was placed in the propagation chamber. It was calculated as the ratio of the sum of the times required for bud emergence to the total number of explants that produced buds.

TAB

$$= \frac{\text{Sum of the times required for bud emergence}}{\text{Total number of explants that produced buds}}$$

The mean number of buds produced (NBP) was determined at the end of the observation period. It was calculated as the ratio of the total number of buds produced to the total number of explants that produced buds.

$$\text{NBP} = \frac{\text{Total number of buds produced}}{\text{Total number of explants that produced buds}}$$

Experimental design and statistical analysis

The suckers were arranged in each propagation chamber according to a completely randomized design (CRD). The experiment was conducted with three independent replicates, with 48 suckers per treatment in each replicate, corresponding to a total of 144 suckers per treatment across the three replicates.

All statistical analyses were performed using STATISTICA version 7.1. Analysis of variance (ANOVA) was performed to determine whether significant differences existed among the factors studied at the 5% significance level. When the ANOVA indicated significant differences, means were separated using the Newman-Keuls multiple range test at the 5% significance level.

RESULTS

Bud induction and production from explants in the propagation chamber

Morphological development of explants and bud emergence

After 7–8 days in the propagation chamber, numerous roots of varying lengths emerged at the surface of the substrate (Figures 2A and 2B). The first buds emerged at the substrate surface 14 days after the explants were placed in the propagation chamber. Initially, these buds exhibited lanceolate leaflets and a whitish appearance, and subsequently developed a greenish coloration. They then developed into leafy shoots of varying sizes (Figures 2C and 2D).

No apparent morphological differences were observed between the leafy shoots produced from non-dehydrated control suckers and those produced from suckers dehydrated for two weeks. Bud emergence at the substrate surface occurred progressively throughout the observation period.





Figure 2. Formation of roots, buds, and leafy shoots from suckers placed in the propagation chamber. (A) non-dehydrated control sucker; (B) sucker dehydrated for two weeks; (C) whitish buds; (D) leafy shoots.

Time to root and bud emergence and mean number of buds produced

The mean times to root emergence were 8.12 days for non-dehydrated suckers (T1) and 7.87 days for suckers dehydrated for two weeks (T2), with no significant difference between the two treatments (P

= 0.54) (Table 1). Similarly, the mean time to bud emergence did not differ significantly between treatments (P = 0.65). In contrast, the mean number of buds produced per explant differed significantly between the two treatments (P = 0.041) and was significantly higher in T2 than in T1 (Table 1).

Table 1. Mean number of buds produced and mean times to root and bud emergence according to treatment

Treatment	Mean time to root emergence (days)	Mean time to bud emergence (days)	Mean number of buds per explant
T1	8.12±0.56 ^a	17.01±2.56 ^a	34.66±21.06 ^b
T2	7.87±0.86 ^a	15.56±3.42 ^a	58.28±31.04 ^a
<i>P-value</i>	0.54	0.65	0.041

Dans une même colonne, les moyennes suivies de la même lettre ne diffèrent pas significativement au seuil de 5 % selon le test de Newman-Keuls. Les valeurs sont exprimées en moyenne ± écart-type.

Bud production kinetics

Regardless of the type of sucker used, bud formation was observed from the third week after the explants were placed in the propagation chamber (Figure 3). At the third week (S3), the number of buds produced was approximately 62 buds per explant in the non-dehydrated suckers and 75 buds per explant in the suckers dehydrated for two weeks. This number subsequently decreased to approximately 49 and 60

buds per explant at S4, and then to 38 and 52 buds per explant at S5, respectively, for non-dehydrated and dehydrated suckers. At S6, the corresponding values were approximately 23 and 45 buds per explant, respectively. Thus, throughout the S3–S6 period, the number of buds produced from the dehydrated suckers remained higher than that obtained from the non-dehydrated suckers.

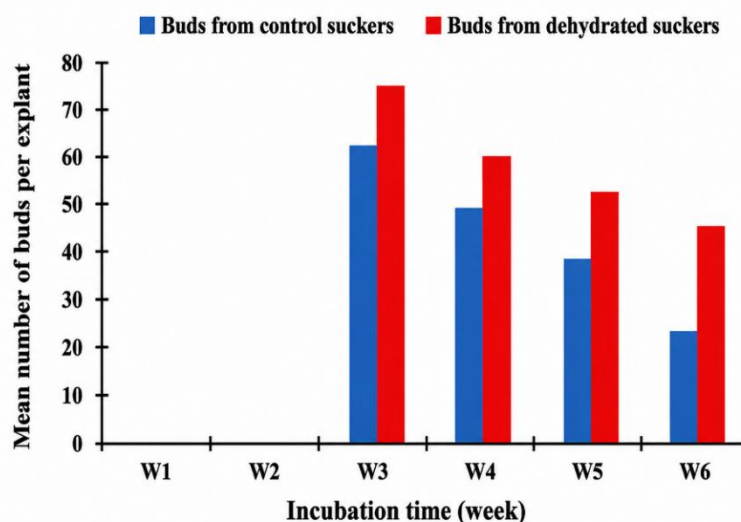


Figure 3. Kinetics of bud production in plantain during incubation of explants in the propagation chamber. W1–W6: 1–6 weeks of incubation;

Changes in biochemical compound contents

During the experiment, total sugar, total protein, and total phenolic compound contents were determined weekly throughout the bud formation process.

Changes in total sugar content

Figure 4 shows the changes in total sugar content of explants derived from non-dehydrated suckers (TEM) and suckers dehydrated for two weeks (DESH). In explants derived from non-dehydrated

suckers, total sugar content decreased during the first week of culture and then progressively increased over the following weeks. In explants derived from dehydrated suckers, total sugar content was higher than that recorded in explants derived from non-dehydrated suckers at the different stages of bud formation. Total sugar content decreased until the third week of culture and then increased following bud emergence.

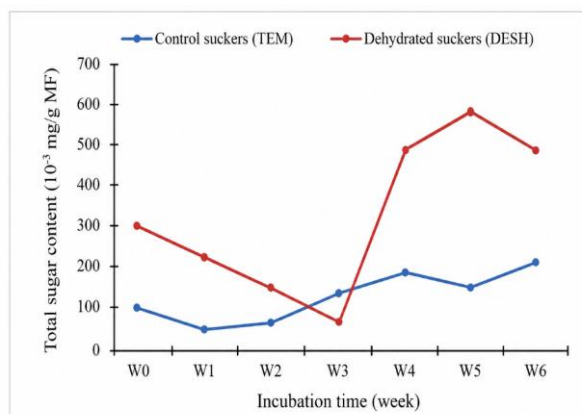


Figure 4. Changes in total sugar content of explants during bud production. W0: initial sampling; W1–W6: 1–6 weeks of incubation; TEM: non-dehydrated control suckers; DESH: suckers dehydrated for two weeks

Changes in total protein content

The changes in total protein content of the dehydrated and non-dehydrated suckers used for bud induction are presented in Figure 5. In non-dehydrated suckers (TEM), total protein content remained relatively stable until the fifth week of incubation, and then increased between the fifth and sixth weeks. In dehydrated suckers (DESH), total protein content was high at the beginning of the experiment and then decreased until the second week. It subsequently increased between the second and fourth weeks before decreasing again until the end of the observation period.

Changes in total phenolic content

Figure 6 presents the changes in total phenolic content of explants derived from non-dehydrated suckers and suckers dehydrated for two weeks. From W0 to W3, both treatments showed a similar pattern in total phenolic content, characterized by an increase from W0 to W1, followed by a decrease until W3. In non-dehydrated suckers (TEM), total phenolic content then increased sharply at W4, decreased at W5, and increased again at W6. In dehydrated suckers (DESH), total phenolic content increased from W3 to W6, reaching approximately 0.95×10^{-3} mg/g FW at W6.

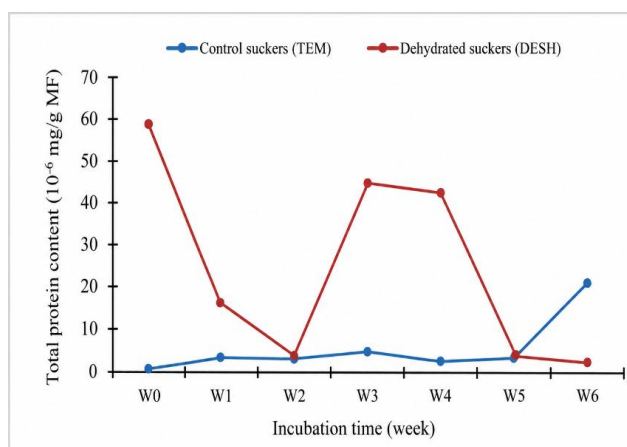


Figure 5. Changes in total protein content of plantain explants during bud production. W0: initial sampling; W1–W6: 1–6 weeks of incubation; TEM: non-dehydrated control suckers; DESH: suckers dehydrated for two weeks

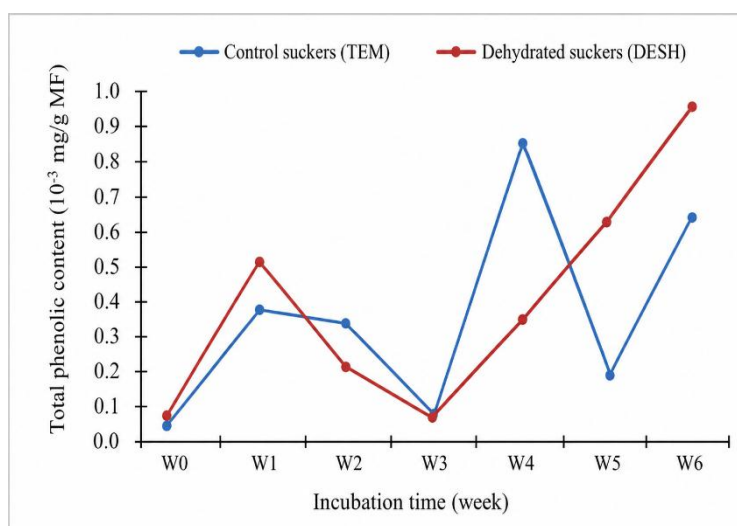


Figure 6. Changes in total phenolic content of plantain explants during bud production. W0: initial sampling; W1–W6: 1–6 weeks of incubation; TEM: non-dehydrated control suckers; DESH: suckers dehydrated for two weeks

Changes in enzymatic activities

The enzymatic activities evaluated during the bud production process included phenylalanine ammonia-lyase (PAL) and peroxidases (POX).

Changes in phenylalanine ammonia-lyase (PAL) activity

Figure 7 presents the changes in phenylalanine ammonia-lyase (PAL) activity during bud production. PAL activity showed different patterns between the two treatments throughout the incubation period. In non-dehydrated suckers (TEM), PAL activity increased sharply from W0 to W1, where it reached its maximum (approximately 7.1×10^{-3} mmol/min/g FW), and then decreased until W3 before increasing again at W4. It subsequently decreased at W5 and W6. In dehydrated suckers (DESH), PAL activity increased slightly from W0 to W1, then increased sharply at W2, where it reached its maximum (approximately 7.0×10^{-3} mmol/min/g FW), before decreasing until W4. It then increased progressively until W6. At W3, PAL activities were similar between the two treatments. At W4 and W5, PAL activity was higher in TEM than in DESH, whereas at W6, it was higher in DESH.

10^{-3} mmol/min/g FW), and then decreased until W3 before increasing again at W4. It subsequently decreased at W5 and W6. In dehydrated suckers (DESH), PAL activity increased slightly from W0 to W1, then increased sharply at W2, where it reached its maximum (approximately 7.0×10^{-3} mmol/min/g FW), before decreasing until W4. It then increased progressively until W6. At W3, PAL activities were similar between the two treatments. At W4 and W5, PAL activity was higher in TEM than in DESH, whereas at W6, it was higher in DESH.

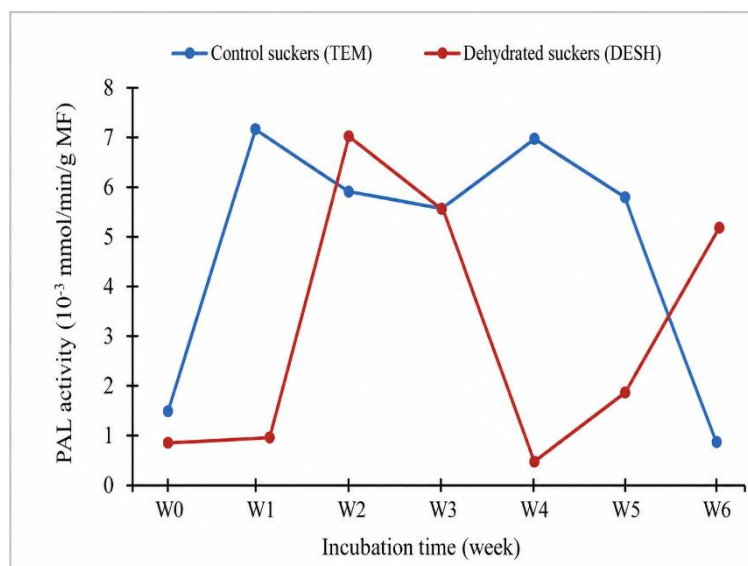


Figure 7. Changes in phenylalanine ammonia-lyase (PAL) activity of plantain explants during bud production. W0: initial sampling; W1–W6: 1–6 weeks of incubation; TEM: non-dehydrated control suckers; DESH: suckers dehydrated for two weeks

Changes in peroxidase (POX) activity

Peroxidase (POX) activity varied differently between non-dehydrated suckers (TEM) and suckers

dehydrated for two weeks (DESH) throughout the incubation period (Figure 8). In non-dehydrated suckers (TEM), POX activity remained relatively

stable between W0 and W1, then increased at W2, reaching its maximum (approximately 2.9×10^{-3} mmol/min/g FW). It then decreased at W3, increased again at W4, and subsequently decreased progressively until W6. In dehydrated suckers (DESH), POX activity increased sharply from W0 to W1 and then decreased at W2. It subsequently increased at W3, reaching approximately 2.3×10^{-3}

mmol/min/g FW, then decreased slightly at W4 and W5 before increasing again at W6.

POX activity was higher in TEM from W0 to W2, whereas it was higher in DESH at W3. The values for the two treatments were similar at W4 and W5. At W6, POX activity was again higher in DESH than in TEM.

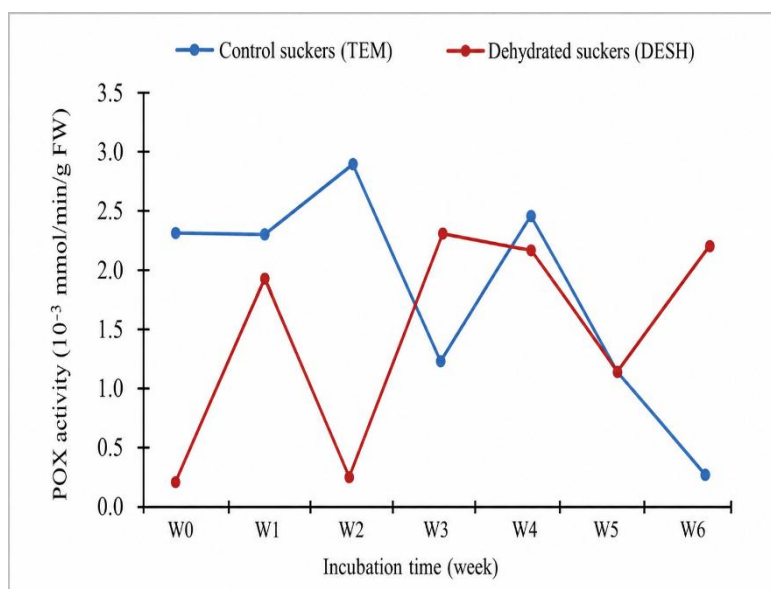


Figure 8. Changes in peroxidase (POX) activity of plantain explants during bud production. W0: initial sampling; W1–W6: 1–6 weeks of incubation; TEM: non-dehydrated control suckers; DESH: suckers dehydrated for two weeks

DISCUSSION

Root emergence was observed 7–8 days after the explants were placed in the propagation chamber, regardless of the treatment applied. Placement in the propagation chamber, followed by tissue rehydration, likely promoted the resumption of metabolic activities required for growth. In dehydrated vegetative organs, rehydration may be accompanied by a resumption of respiratory activity and de novo synthesis of enzymes involved in reserve mobilization (Boyé et al., 2010). In the present study, however, the mean number of buds produced differed significantly between the two treatments, with higher bud production observed in suckers dehydrated for two weeks.

Shoots produced from dehydrated suckers exhibited morphological characteristics comparable to those obtained from non-dehydrated suckers. However, dehydrated suckers produced a significantly higher mean number of buds. This difference suggests that prior dehydration may promote bud induction and/or production under the experimental conditions used. This response could be related to changes in the physiological status of the tissues and the subsequent mobilization of reserve compounds during rehydration. The rhizome of plantain suckers constitutes a reserve organ rich in starch (Turquin,

1998), whose mobilization could contribute to providing the carbon substrates required for renewed growth and the formation of new buds.

The dynamics of total sugar content differed between treatments. In non-dehydrated suckers, sugar content decreased slightly during the first week and then increased during the following weeks. In dehydrated suckers, sugar content decreased until the third week, corresponding to the onset of bud production, and then increased. This initial decrease could be associated with the utilization of available sugars during the resumption of metabolic activity and the formation of new organs. Carbohydrates serve as respiratory substrates and carbon sources required for cell growth (Murphy, 1993). The increase observed after bud emergence could subsequently correspond to progressive sugar accumulation in the tissues. However, this increase cannot be directly attributed to photosynthetic activity, as photosynthesis was not assessed in the present study.

Protein content also showed different patterns depending on the treatment. In dehydrated suckers, a high protein content was observed at the beginning of the experiment, followed by a decrease until the second week and then an increase between the second and fourth weeks. This pattern could reflect changes in protein metabolism during rehydration and new organ formation. Proteins serve as

functional molecules and nitrogen reserves that can be mobilized during the resumption of growth. An increase in protein synthesis is also associated with the release from dormancy in certain vegetative organs (Apelbaum, 1984; Macdonald & Osborne, 1988). In non-dehydrated suckers, protein content remained relatively stable until the fifth week and then increased in the sixth week. These results indicate that protein dynamics depended on both the treatment and the developmental stage of the explants. However, the data obtained do not allow determination of whether these variations resulted primarily from protein synthesis or degradation.

Phenolic compounds also varied during incubation. From W0 to W3, both treatments showed a similar pattern, characterized by an initial increase followed by a decrease. From W3 onward, the patterns diverged: in dehydrated suckers, phenolic compound content increased progressively until W6, whereas in non-dehydrated suckers, it showed successive fluctuations. Phenolic compounds constitute an important class of plant secondary metabolites, and their accumulation can be affected by various environmental and physiological factors. The increase observed at the beginning of incubation could be associated with the response of tissues to the stresses imposed during explant preparation and placement in the propagation chamber. Subsequent variations could correspond to changes in their synthesis, utilization, or transformation during bud development. Zhao et al. (2004) showed that different signaling pathways can regulate secondary metabolite production in response to external stimuli. The more consistent accumulation of phenolic compounds in dehydrated suckers from W3 onward could therefore reflect a different metabolic response between the two treatments.

Phenylalanine ammonia-lyase (PAL) activity, a key enzyme in the phenylpropanoid pathway, also varied during incubation. In non-dehydrated suckers, PAL activity reached an initial maximum at W1, then decreased until W3 before increasing again at W4. In dehydrated suckers, the maximum was reached at W2, followed by a decrease until W4 and a subsequent increase until W6. These patterns indicate that PAL activity varied according to both treatment and developmental stage. PAL catalyzes the entry of phenylalanine into the phenylpropanoid biosynthetic pathway and may contribute to the regulation of phenolic compound accumulation (Zucker, 1965; Heller & Forkman, 1993). The partial correspondence between changes in PAL activity and those in total phenolic content suggests a relationship between PAL activity and phenolic metabolism during bud production. However, measurement of PAL activity alone does not establish a direct causal relationship with phenolic compound accumulation, which also depends on other enzymes and metabolic pathways.

Peroxidase (POX) activity fluctuated during incubation in both treatments. In non-dehydrated suckers, activity reached its maximum at W2, whereas in dehydrated suckers, the highest level was observed at W3. The patterns also differed between treatments throughout the observation period, with higher activity in non-dehydrated suckers from W0 to W2 and higher activity in dehydrated suckers at W3 and W6. Peroxidases participate in several physiological processes, including oxidation–reduction reactions, responses to stress, and processes associated with plant tissue development (Santimone, 1973). The fluctuations observed may therefore reflect changes in enzymatic activity associated with the different developmental stages of the explants. Nevertheless, POX activity alone does not allow its use as a direct indicator of sucker degradation or preservation.

CONCLUSION

This study showed that prior dehydration of plantain suckers of the ‘Corne 1’ cultivar was associated with increased bud production during macropropagation. Suckers dehydrated for two weeks produced a significantly higher mean number of buds than non-dehydrated suckers, with no apparent morphological differences between the shoots produced. Bud formation was also accompanied by temporal changes in total sugar, protein, and phenolic compound contents, as well as in PAL and POX activities. These patterns differed between dehydrated and non-dehydrated suckers, indicating differences in their biochemical and enzymatic dynamics during bud production. Overall, the findings suggest that prior dehydration could be a useful approach for increasing bud production during plantain macropropagation and provide initial insights into the biochemical and enzymatic changes associated with this process. Further studies involving starch reserves, individual sugars, plant hormones, specific proteins, and additional enzymes involved in reserve mobilization would help clarify the physiological mechanisms underlying the response to dehydration.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest that could have influenced the work reported in this manuscript.

REFERENCES

Apelbaum, A. (1984). Polyamines as possible indicators of physiological age. *Potato Research*, 27, 309–318.

[Google Scholar](#)

Bonte, E., Verdonck, R. and Gregoire, L. (1995). La multiplication rapide du bananier et du plantain au Cameroun. *Tropicultura*, **13**(3), 109–116.

[Google Scholar](#)

Boyé, M. A. D., Turquin, L., Gnahoua, J. B. G., Coulibaly, D. R., Aké, S. and Anno, A. (2010). Performances agronomiques de bananiers plantain *Musa* AAB cv. ‘Corne 1’ issus de rejets déshydratés pendant un mois. *Journal of Animal and Plant Sciences*, **7**(1), 767–778.

[Google Scholar](#)

Bradford, M. M. (1976). A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein–dye binding. *Analytical Biochemistry*, **72**, 248–254.

[Google Scholar](#)

Dubois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. A. and Smith, F. (1956). Colorimetric method for determination of sugars and related substances. *Analytical Chemistry*, **28**(3), 350–356.

[Google Scholar](#)

Heller, W. and Forkmann, G. (1993). Biosynthesis of flavonoids: Advances in research since 1986. In [Titre de l’ouvrage à préciser] (pp. 499–?).

[Google Scholar](#)

Konan, Y. K. F., Kouassi, K. M., Kouakou, K. L., Koffi, E., Sekou, D., Kone, M. and Kouakou, T. H. (2014). Effect of methyl jasmonate on phytoalexins biosynthesis and induced disease resistance to *Fusarium oxysporum* f. sp. *vasinfectum* in cotton (*Gossypium hirsutum* L.). *International Journal of Agronomy*, 11 p.

[Google Scholar](#)

Koné, T., Soumahoro, B. A., Coulibaly, K. Z., Traoré, S., Koné, D. and Koné, M. (2016). Effects of substrates, weight and physiological stage of suckers on massive propagation of plantain (*Musa paradisiaca* L.). *International Journal of Research – GRANTHAALAYAH*, **4**(1), 1–13.

[Google Scholar](#)

Koua, T. C. (2014). *Effets de différents types de substrats sur la croissance des vivo-plants de bananiers plantain (Musa sp.) en phase d’acclimatation* [Mémoire de master, Université Nangui Abrogoua].

[Google Scholar](#)

Macdonald, M. M. and Osborne, D. J. (1988). Synthesis of nucleic acids and protein in tuber buds of *Solanum tuberosum* during dormancy and early sprouting. *Physiologia Plantarum*, **73**, 392–400.

[Google Scholar](#)

Murphy, D. J. (1993). Plant lipids: Their metabolism, function and utilization. *Plant Biochemistry and Molecular Biology*, **5**, 113–128.

[Google Scholar](#)

Santimone, M. (1973). *Mécanisme des réactions d’oxydation peroxydasiques* [Thèse d’État, Université d’Aix-Marseille II].

[Google Scholar](#)

Shirani, S., Mahdavi, F. and Maziah, M. (2009). Morphological abnormality among regenerated shoots of banana and plantain (*Musa* spp.) after in vitro multiplication with TDZ and BAP from excised shoot tips. *African Journal of Biotechnology*, **8**(21), 5755–5761.

[Google Scholar](#)

Turquin, L. (1998). *Contribution à l’étude de la croissance et du développement des rejets de type B chez le bananier plantain (Musa AAB cv. Corne 1): Activité de quelques analogues structuraux de l’acide phénoxyacétique (APA)* [Thèse de doctorat, Université d’Aix-Marseille I].

[Google Scholar](#)

Yin, Z., Sadok, A., Sailem, H., McCarthy, A., Xia, X., Li, F., Garcia, M. A., Evans, L., Barr, A. R., Perrimon, N., Marshall, C. J., Wong, S. T. and Bakal, C. (2013). A screen for morphological complexity identifies regulators of switch-like transitions between discrete cell shapes. *Nature Cell Biology*, **15**(7), 860–871.

[Google Scholar](#)

Zhao, J., Davis, L. C. and Verpoorte, R. (2004). Elicitor signal transduction leading to production of plant secondary metabolites. *Biotechnology Advances*, **23**(4), 283–333.

[Google Scholar](#)

Zucker, M. (1965). Induction of phenylalanine deaminase by light and its relation to chlorogenic acid synthesis in potato tissues. *Plant Physiology*, **40**, 779–784.

[Google Scholar](#)