Journal of Genetic and Environmental Conservation, 2024, 12(1):17-22.
www.jogec.com Print ISSN: 3007-4509, Online ISSN: 3007-4517

Senna seed germination and seedling growth stimulation by the use of gamma rays and electric shock

Yasamen F. Salloom[1]*, Hussein A. Almrani[2] and Mohammed S. Taher[3]
[1]University of Baghdad, College of Agriculture, Department of Horticulture and Landscape Design, Al-Jadiriya, Baghdad, Iraq. [2,3]University of Baghdad, College of Agriculture, Unit of Medical and Aromatic Plants Research, Al-Jadiriya, Baghdad, Iraq.
***Corresponding author: yasamen.f@coagr.uobaghdad.edu.iq**
Received: November 11th 2023; Accepted: December 5th 2023; Published: February 5th 2024

Abstract
The experiment, which examined the effects of electric shock and irradiation on indicators of senna seed germination and seedling growth, was conducted in labs and fields owned by the Medicinal and Aromatic Plants Research Unit of the College of Agricultural Engineering Sciences at the University of Baghdad in 2019. The experiment used an RCBD design with three replications and included six treatments (T1), seed electric shock with 4 and 6 Ampere (T2, T3), and seed irradiation with 10, 20, and 30 Gry (T4, T5, and T6). The findings revealed that the T4 and T3 treatments had the highest germination rates, wet weights of seedlings, and dry weights of roots, respectively, of 33.3, 32%, 0.225, 0.220 g, and 0.178, 0.167 g, while T2 and T4 had the highest dry weights of seedlings (0.0450, 0.0420 g, respectively). The highest levels of chlorophyll (SPAD) were found in the T2 and T3 treatments (44.17 and 43.7, respectively), indicating the importance of gamma rays and electric shock in promoting seed germination and seedling growth.

Keywords: Senna, Electric shocks, Germination, Gamma rays, Seedling.

Introduction
Cassia senna L. one of the important medicinal plants, From the Fabaceae family. The Arabian island, Egypt, Sudan, India, Pakistan, and Iran are its natural habitats. In semi-arid and desert areas, it is widely cultivated. The Arabic name for the plant's is Hegazy, also known as Alexandrian, Senna is cultivated for its branches, flowers, fruits, and leaves, which are all utilized in herbal concoctions, one of the best laxatives, are the leaves and fruits. Additionally, jaundice, an enlarged spleen, and kidney conditions are treated with it as a folk remedy, Typhoid and anemia Senna has long been used as a laxative by populations in North Africa and Southwest Asia, Anthraquinone derivatives, including some free and reduced di-anthrone and others linked in the form of sennosides of the two types a, b, as well as gelatinous materials, flavonoids, and volatile oil, are present in senna's leaves and fruits in amounts ranging from 2.5 to 4% (Abu Zaid, 2000; Al-Hakim et al., 2012). Senna plants are important, so efforts have been made to grow and improve them using various techniques in order to maximize seed germination. One of these techniques is the use of electric shocks, Since there is a low energy in the seeds ranging from 6-26 mv, this energy can be exploited to test the effect of the high difference in electrical voltage applied to the seeds to cause changes in the plants (Elsahookie 1992, Nelson 2000, Elsahookie and Elsabahy 2001, El Samurai 2010). It was noted that physiological, chemical, biological, and genetic changes occurred in the seeds of carrots as the germination percentage increased to 24%, radishes and beets to 12%, and barley seeds to 9% (Lynikiene et al; 2006). The use of 6 Ampere for 7 minutes greatly accelerated germination, increased germination percentage, and lengthened roots in sweet pepper(Omran, 2014). Another significant contemporary technique is the use of gamma radiation at various intensities to promote germination and enhance the characteristics of vegetative growth due to its role in accelerating the rate of transformation of nutrients stored in seeds from a complex to a simple state that is amenable to use by the developing embryo through its activation of enzymes (lipase, -amylase, a protease), or lead to an increase in the rate of synthesis of growth stimulants such as gibberellic acid and auxins relative to its inhibitors (ABA,

phenolic compounds), which contributes to stimulating germination, in addition to the role of gamma rays in activating physiological and biochemical processes that lead to seedlings emerge above the soil surface, this has a positive impact on the size of the vegetative part that is useful in the process of photosynthesis on the one hand and on the production of dry matter required to speed up the growth and development of plants on the other (Lee et al., 2005; Piri et al., 2011). Also result from its absorption by living things and transmission—directly or indirectly—to sensitive cell parts during construction and demolition processes, which affect important cell components and enhance the morphological traits of plants (Moussa, 2006; Hameed et al., 2008). Consequently, the aim In this work, low-cost and low-effort therapies such as electric shock the seeds and low-dose (stimulatory only) gamma ray irradiation are used to stimulate the germination of senna seeds and the growth of seedlings.

Materials and Methods

The experiment was conducted in the 2019–2020 growing season at the College of Agricultural Engineering Sciences, University of Baghdad, in the Medicinal and Aromatic Plants Research Unit to investigate the effects of electric shock and gamma radiation on seed stimulation and the growth of Senna seedlings until the development of four true leaves. Three replications of a completely randomized block design (RCBD) were utilized to include Each repetition includes 6 experimental units with 10 plants each, totaling 180 plants in the experimental units. The growth traits are compared using the least significant difference (LSD) 5% test (Al-Sahoki and Wahib, 1990). The research includes the following treatments: Soak the seeds only in water (T0) , shock electric seeds at 4, 6, 10 Ampere (T1, T2, and T3 respectively) , seed are irradiated at 20 , 30, 40 Gry (T4 and T5 respectively).

The seeds were separated into 18 groups according to the number of experimental units, each of which had 100 seeds that were Placed in airtight bags that allow water to enter, three groups were soaked in water only for 12 hours(control with replicates), While the 6 groups were soaked in water for 12 hours then placing the seeds in a specific glass electrocution basin with water that is at a level to cover them and contains a concentration of 1% NaCl salt, then shocked three groups at 4 and three groups at 6 Ampere (with replicates) was applied to them for three minutes. The other 9 groups involved irradiating senna seeds with gamma rays at three levels with replicate (10, 20, and 30 Gry) by placing them in the irradiation device using cobalt 60. After completing the experimental treatments, the seeds were planted in cork dishes using Peat moss . After germination, the seedlings were transferred to 5 kg utensils, and all of the seeds were then planted. Measurements were carried out on 10 plants per experimental unit. The following equation was used to determine the percentage of germination: Germination percentage (%) = (Number of germinated seeds / Total number of sown seeds) x 100(ISTA, 2013). Germination speed (day) was calculated by calculating the number of germinated seeds in each count / the time period between each count and the next. Five plants(seedling) were selected from each experimental unit for the following measurements: Seedling length (cm): Measured by using a tape measure from the point where the plant touches the ground up to the top of the seedling. Average wet weight of the seedling (gm): The shoot was separated from the root, then the shoot was placed in paper bags, weighed with a sensitive scale. Average dry weight of seedlings (gm): The samples were placed in the electric oven at 65 oC until the weight stabilized, and weighed using a sensitive, the dry samples were then weighed, and the average of those weights was determined. Average root wet weight (g): The roots were collected, thoroughly cleaned with water to remove any remaining soil, and then allowed to dry naturally, The fresh and dry weight of the root was measured in the same way as the shoot (Al Sahhaf, 1989). According to Jemison and Williams (2006), the relative amount of chlorophyll in leaves, measured in SPAD UNITS, was assessed by a chlorophyll meter by calculates the average of the readings from 5 leaves of plants for each experimental unit.

Results and Discussion

Germination percentage: Figure 1 shows the difference in the percentage of germination of senna seeds with different treatments, as it is noted that the irradiation treatment at T4 (20 Gry) was superior of the other treatments by giving it the highest percentage of germination (33.3%), followed by the T3 treatment with a germination rate reached 32%, treatment Irradiation T5 (28%) and the electric shock treatment T1 (27%), while the lowest rates of germination were in the treatments T0 and T2 (26% and 25%, respectively).

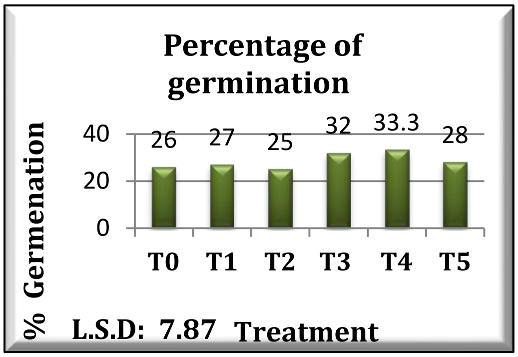

Figure 1 shows the effect of electric shock and gamma radiation on the percentage of germination of senna seeds.

Germination speed (day): Figure 2 shows the variation in the germination speed of senna seeds with different treatments. The results showed that the irradiation treatment at T3 (10 Gry) showed a significant superiority, as it took the least number of days for germination (4 days) compared to the other treatments, followed by the treatments, T4 and T5, by a germination speed of 5 and 6. day, and the electric shock treatment T2 (8 days), while the lowest germination speed was in the T0 and T1 treatment (9 and 10 days respectively).

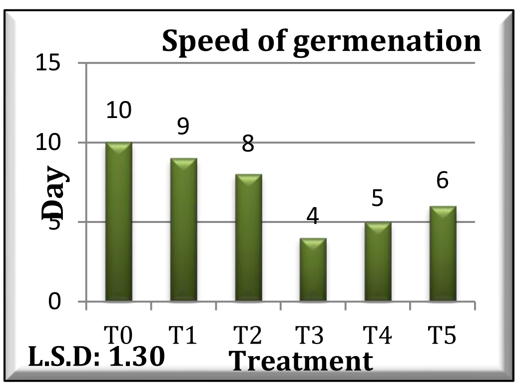

Figure (2): shows the effect of electric shock and gamma radiation on the germination speed of senna seeds.

Seedling length (cm): It is clear from Figure 3 that the different treatments had a significant effect on the length of the seedlings, as the irradiation treatment at T3 (10 Gry) was characterized by giving it the highest length of the seedlings reaced 6.67 cm, followed by the T5 treatment (6.47 cm), While the length of the seedlings reached 6.3 cm at electric shock treatment T2, and it is noted from the above figure that the length of the seedlings decreased to 4.57 and 5.37 cm at the treatments T0 and T1, respectively.

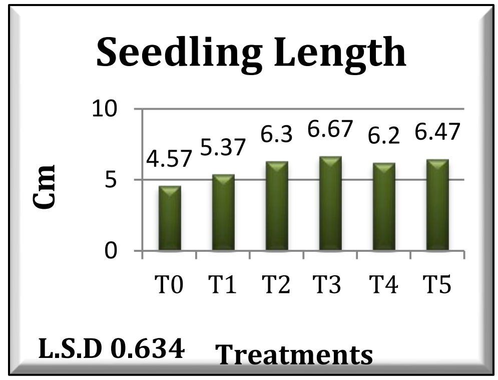

Figure 3 Effect of electric shock and gamma radiation on the length of senna seedlings (cm).

Seedling wet weight (gm): Figure 4 shows that the average wet weight of the seedlings was affected by the different levels of irradiation (gamma rays) . The irradiation treatment T4 (20 Gry) was characterized by its significant superiority, it giving the highest average wet weight of the seedlings amounting to 0.23 gm, followed by the T3 treatment (0.22 gm), and for the electric shock treatments, it gave The treatment (T2) 0.20 gm, followed by the treatment T1 with an average of 0.19 gm. While the lowest mean of the wet weight of the seedlings was found in the treatments T0 and T5 (0.17 gm for both treatments).

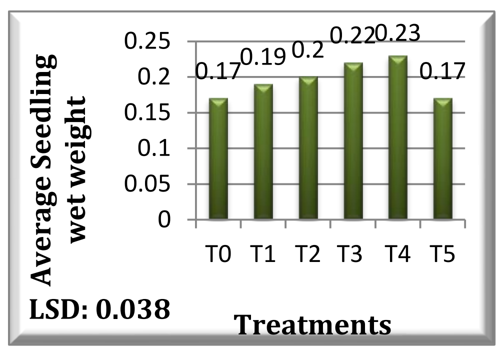

Figure 4 shows the effect of electric shock and gamma radiation on the average wet weight of senna seedlings (gm).

Average dry weight of seedlings (gm): Figure 5 shows that there is no significant difference between the treatments, although the electric shock treatment T2 (6 Ampere) gave the highest average dry weight of seedlings amounting to 0.045 gm, followed by the T4 treatment (00.42 gm), and the T3 irradiation treatment (0.038 gm), followed by the treatments T1 and T5 with an average dry weight of 0.033 gm for both, while T0 treatment gave the lowest average reached 0.029 mg for seedlings.

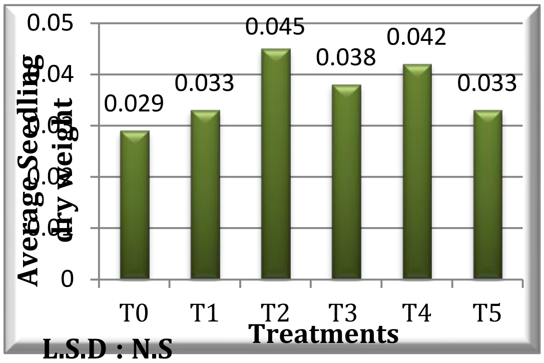

Figure 5. The effect of electric shock and gamma radiation on the average dry weight of senna seedlings (gm).

Root length (cm): The results of Figure 6 show the significantly superiority of the gamma irradiation treatment T5 (30 Gry) by giving it the highest root length (14.03 cm), followed by the T3 and T4 treatments with a root length (13.93 and 13.07 cm). and T2 treatment (11.37 cm), cm, while treatment T0 and T1 gave the lowest root length, which was 8.72 and 9.63 cm respectively.

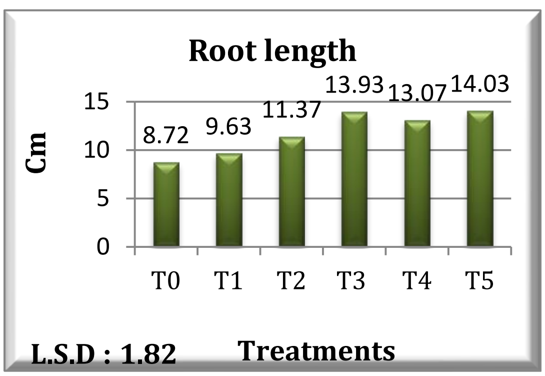

Figure 6 shows the effect of electrocution and gamma radiation on the root length of senna seedling (cm).

Root wet weight (gm): The results of Figure 7 showed the superiority of the gamma irradiation treatment T3 (10 Gry) by giving it the highest average root wet weight reached 0.368 g, followed by the T4 treatment (0.361 g). Regarding the effect of electric shock, it was noted that the T2 treatment was superior by giving it a wet weight (0.285 g). While the lowest wet weight was recorded at control (0.221 g).

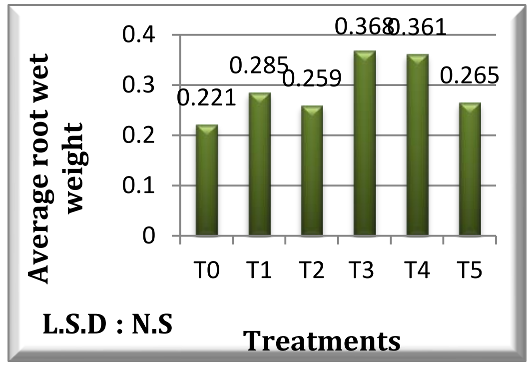

Figure 7 shows the effect of electric shock and gamma radiation on the wet weight of the root of senna seedlings (gm).

Root dry weight (gm): From figure 8 was noted that the treatment T4 (irradiation by 20 Gry) gave the highest average dry weight of the root reached (0.178 g), followed by the treatment T3 reached 0.178 gm. in treatments of electric shock was observed that T1 treatment has given 0.127 gm, followed by T2 treatment (0.113 gm), while the control gave the lowest rate of dry weight (0.096 gm).

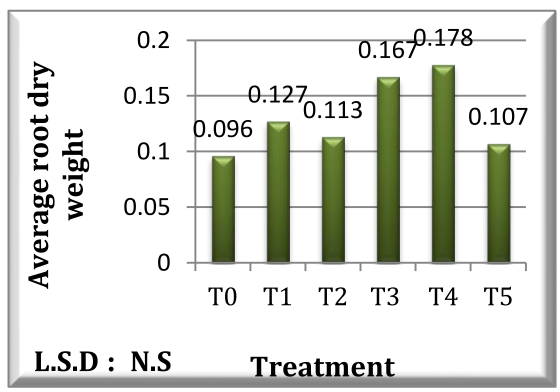

Figure 8 shows the effect of electric shock and gamma radiation on the dry weight of the roots of senna seedlings (gm).

Chlorophyll content (SPAD): From figure 9 shows that the irradiation treatment T3 (10 Gry) was significantly superior as it gave the highest chlorophyll content in the seedlings amounting to 43.70 SPAD, followed by the T5 treatment by a chlorophyll content of (42.53 SPAD), then T4 treatment (40.23 SPAD). As for the effect of electric shock, superiority was observed in T2 treatment, which gave it the highest chlorophyll content reached 44.17 SPAD, while reached lowest values at the treatment T1 and T0 (34.77 and 36.03 SPAD respectively).

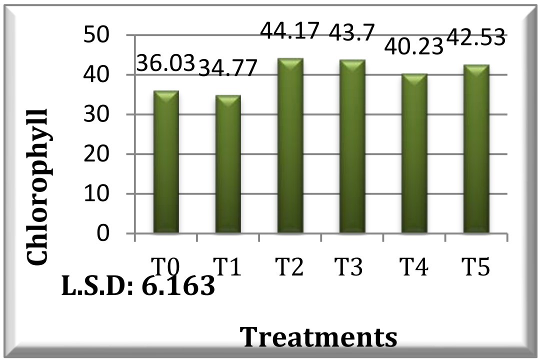

Figure 9 shows the effect of electric shock and gamma radiation on the chlorophyll content in the leaves of senna seedlings (SPAD).

The clear impact of physical treatments on the study's characteristics was demonstrated in the previous figures, particularly those for gamma radiation T3 (10 Gry) and Electric shock's T2 (4 Ampere). In order to prepare strong seedlings and develop a field that can be mirrored in future plant growth, it is crucial to encourage the growth of seedlings.

Numerous physiological effects of these physical treatments have been mentioned in prior studies. Electric shock's ability to induce osmotic equilibrium by induction or electrical tension, change cellular pH both inside and outside of the cell, allow transport across cellular membranes, and stimulate metabolic activity in cells are all possible explanations for its stimulating effects. causing alterations in the physiology, chemistry, and biology that boosted water absorption (Al Taweel et al., 2018), which in turn sped up seed germination (Fig. 1, 2). The characteristics of vegetative growth, particularly chlorophyll pigment (Fig. 9) and root traits (Lynikiene et al. 2006), as well as the increased metabolism of key metabolites in the growth of vegetative plant tissues (Figs. 3, 4, and 5) and root traits (Figs. 6, and 7), were affected by these physiological and chemical changes. As for the stimulating effect of gamma rays, the reason may be due to the role of gamma rays in increasing the level of hydrolytic enzymes (α - amylase, lipase, and protease) which are responsible for converting nutrients from a complex state to a simple state), as well as increasing the level of growth-encouraging hormones (Auxins and GA3) vs. (ABA and phenolic compounds), which facilitates the use of nutrients by the embryo (Al-Awda et al., 2004). Or by increasing the effectiveness of RNA in protein synthesis during the early stages of germination (Akshatha and Chandrashekar, 2013) and benefiting from it in increasing cell division and elongation (Jaipo et al., 2019), which leads to an increase in the percentage and speed of germination and its reflection on plant performance and the formation of vegetative and root growth for seedlings. Therefore, the increase in vegetative growth means an increase in the green surface that intercepts the light, which means a rise in the efficiency of photosynthesis, especially when chlorophyll is increased (Fig. 9) and metabolic processes, anabolism versus catabolism, which is reflected in an increase in the accumulation of dry matter and the characteristics of vegetative and root growth (Al-Amrani et al., 2016 and Al-Abdullah et al., 2018).

Conclusion

From the aforementioned, we draw the conclusion that it is possible to stimulate seed germination (for example, in senna seeds) by increasing the percentage and speed of germination and early growth of seedlings, as well as how this is reflected in their growth and accumulation of dry matter, especially when increasing the chlorophyll content by using stimulating physical treatments (electric shock and irradiation of seeds), which are low-cost, Which indicates a strong field establishment that is reflected in the future performance of the plant.

References

Abu Zaid, S. N. (2000). Medicinal plants and herbs. Arab House for Publishing and Distribution. Second Edition . p. 577.

Akshatha and K. R. Chandrashekar. (2013). Effect of gamma irradiation on germination growth and biochemical parameters of *Pterocarpus santalinus*, an endangered species of Eastern Ghats. European Journal of Experimental Biology, 3(2):266-270.

Al Taweel, S. K., S. H. Cheyed and H. A. Al Amrani. (2018). Effect of electric shock on germination and seedling growth in henbane species. Academia Journal of Medicinal Plants 6(5): 071-078.

Al-Abdullah, O., M. N. Al-Ayoubi and R.Al-Babili. (2018). The Effect of Different Doses of Gamma Radiation on the Growth and Productivity of Garlic. Allium sativum L., the local Yabrudian cultivar in Syria. Syrian Journal of Agricultural Research 2) 5.) 1-9:., Syrian Journal of Agricultural Research 5(2):1-9.

Al-Amrani H. A., I. J. Abdul Rasul and S. O. Muhammad. (2016). The Effect of Organic Fertilizers and Magnetized Water on the Growth and Yield of Fixed Oil and Its Components of Medicinal Pumpkin. Iraqi Agricultural Sciences Journal. 47(1): 271-282.

Al-Awda, A., H Kayal and M. Khiti. (2004).The effect of radioactive stimulation on the morphological characteristics and yield components of two cultivars (Sham 3, Hourani) of durum wheat (Triticum durum). Damascus University Journal of Agricultural Sciences . Volume (20), Issue One, Pages 127-142.

Al-Hakim, W. H, M. B. Al-Saadi., E. H. Agha, I. S. Al-Qadi., A. Abdel-Fattah Dirkalt., Z. S. Al-Shater., H. Ibrahim and M. S. Qarbisa. (2012). Atlas of medicinal and aromatic plants in the Arab world. National Center for the Studies of Arid Zones and Dry Lands. Aksad. Damascus. p. 633.

Al-Sahoki, M. M. and W. Al-Sabahi. (2001). Inducing genetic variations in wheat and barley by electrocution. Iraqi Agricultural Sciences Journal. Volume 32, Issue 3, 139-146.

Al-Samarrai, S. Khalil. (2010). Hybrid vigor and combinability in courgette squash and its response to electrocution. Master's thesis, Department of Horticulture, College of Agriculture, University of Baghdad. Iraq. p. 137.

El-Sahookie, M.M. (1992). Evaluation of soybean mutants induced by electric Shock. Iraqi J. Agric. Sci.23(2):99-105.

Hameed, A., T.S .Mahmud., B.M. Atta., M.A Haq and H. Sayed. (2008). Gamma irradiation effects on seed germination and growth, protein content, peroxidase and protease activity, lipid peroxidation in desi and kabuli chickpea. Pak. J. Bot. 40, 1033–1041.

ISTA (International Seed Testing Association. (2013). International Rules for Seed Testing. Adopted at the Ordinary Meeting.2012, Budapest, Hungary to become effective on1 st January 2005. The International Seed Testing Association. (ISTA).

Jaipo, N., M. Kosiwikul., N. Panpuang and K Prakrajang.(2019). Low dose gamma radiation effects on seed germination and seedling growth of cucumber and okra. Journal of Physics: Conference Series. doi:10.1088/1742-6596/1380/1/012106.

Lee, S., M. Lee and K. Song .(2005). Effect of gamma-irradiation on the physicochemical properties of gluten films. Food Chem. 92: 621– 925.

Lynikiene S., A . Pozeliene and G .Rutkaushas . (2006) . Influence of corona discharge field on seed viability and dynamics of germination. Agrophysic ,20:195- 200. Environment, 25(2): 239-250.

Moussa, J.P. (2006) . Role of gamma irradiation in regulation of NO3 level in rocket (Eruca vescaria subsp. sativa) plants. Russ. J. Plant Physiol. 53, 193–197.

Nelson, A. (2000). Elctro-Culture(Chapter 5). Internet eden.www.rexresearch.com.

Omran, W. H. H. (2014). The role of some physical factors in indicators of germination, growth and yield in sweet pepper. PhD thesis. faculty of Agriculture. Baghdad University. Iraq.

Piri, I.; B. Mehdi.; T. Abolfazl; and J. Mehdi .2011. The use of gamma irradiation in agriculture. African Journal of Microbiology Research. 5 (32): 5806- 5811.