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Effect of NPK fertilizers on chemical constituents of *Aloe vera* leaves

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Abstract

A field study was conducted in *Aloe vera* syn *Aloe barbadensis* with an objective to determine the effect of various levels of synthetic fertilizers (10:10:10: 20:20:20: 40:40:40: 80:80:80: N:P_2O_5:K_2O kg/ha) on chemical constituents at the inflorescence stage of the plant (12 months old). The active principles were assessed from the gel (mucilaginous tissue of leaf) and juice (yellow exudate from the base of leaf). The results suggested that free o-glycones and o-glycosides were not affected by levels of NPK nutrients applied, but c-glycosides, anhydrous barbaloin and hydroxy anthroquinone derivatives were significantly affected with application of NPK fertilizers at 40:40:40 or 80:80:80 N:P_2O_5:K_2O kg/ha. The recovery of total polysaccharides from gel ranged from 0.52% from control to 0.89% in 40:40:40 applied plots. Anhydrous barbaloin content estimated using HPLC technique and colorimetric methods were comparable Aloe emodin was found absent in all samples. Aloesin content ranged from 10.60 to 13.10% in Aloe juice and there was no significant difference across treatments. The recovery of Aloe juice ranged from 0.050 to 0.066% on dry weight basis.

Key words: *Aloe vera*, NPK, juice, gel, total polysaccharides, free o-glycones, o-glycosides, anhydrous barbaloin, hydroxy anthroquinone derivatives.

1. Introduction

Aloe vera is one of the oldest plants known to the human mankind for its medicinal properties. The first document available dates back to 2200 BC describing the healing power described in Sumerian tablet found in Egyptian civilisation. The two most important products of *Aloe* are mucilaginous tissue embedded in the leaf (gel) and the yellow juice obtained when the leaf sheath is cut at the base (juice). This yellow juice is an exudate from the inner epidermal layers or from a row of fibro vascular bundles, the cells of which are much enlarged and filled with a yellow juice which exudes when the leaf is cut. *Aloe* gel is a mucilaginous translucent mass consisting of parenchymatous cells beneath the leaf, primarily rich in water and polysaccharides is known as gel. *Aloe* is being used for wound

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healing (1), skin disorders (2), inflammation and general skin care cosmetics (3). *Aloe* is known to possess anti-microbial activity (4), antiviral activity (5), hepato-protective activity (6), anti-allergic activity (7). There is a growing health consciousness among public using the health care products and equally there is a concern for herbal drugs known to promote desirable effects with less side effects. *Aloe vera* is one such herb where the cosmetic industry is making many health products and the quality of the herb in terms of active principles is required to be defined. In view of non-availability of the herb in the natural habitat there is a need to cultivate the herb and there is also need to generate data base of active principles under given set of agronomic conditions. There is dearth of information on the active principles of *Aloe vera* when cultivated under varied cultural practices. Hence this experiment was designed to evaluate the concentration of active principles under varied levels of fertilizers.

2. Materials and Methods

The field experiment was laid out at Indian Institute of Horticultural Research (13°58[1] latitude North; 78° longitude East) Hessaraghatta on the red loamy soils (Udic Haplustalf) having acidic pH (5.50); low in available N, P and high available K. *Aloe vera* suckers, aged nearly 1½ months, having 4 leaves were brought from Tirupathur, Tamil Nadu. The suckers were dipped in a fungicide to disinfect against any fungal contamination. They were planted at a distance of 60x60 cm, accommodating 27,778 plants/ha. and five treatments were designed with four levels of fertilizers and a control (without fertilizer).

The fertilizers were applied at four levels namely 10:10:10; 20:20:20; 40:40:40: 80:80:80 $N:P_2O_5:K_2O$ kg/ha. The plant sample was drawn for analysis at the end of twelve months where the plant has just completed its flowering and the flowers had withered from flower stalk. The basal leaves were sampled for gel and a minimum of three leaves from each plant were taken as unit and samples pooled from three such units formed a replication and the study was conducted in three replications. The juice was also collected from the leaves that were used for gel. The hydroxyanthraquinone derivatives were estimated using the methods as described in Indian Herbal pharmacopoeia (8, 9). Anhydrous barbaloin and Aloe emodin were estimated using HPLC techniques as described (10). HPLC was housed at IIHR (Waters, dual pump, 7486 Model) and the instrument was operated at optimal conditions (UV lamp detector at 290 nm). The sample was pumped through a column (Spherisorb 5 µm) at a flow rate of 2ml per minute at 25°C. The mobile phase consisted of Acetonitrile and water (0.6:1.4) with an isocratic eluent. The data was processed for ANOVA using standard statistical procedures.

3. Results and Discussion

3.1 Effect of fertilizers on Aloe Juice

Effect of NPK fertilizers was assessed on the yield of *Aloe* juice from the present study it was found that there was significant difference between the control (no fertilizers) and the fertilizers applied treatments in respect of *Aloe* juice production. Highest *Aloe* juice was harvested from the plants applied with highest dose of NPK fertilizers. However there was no significant difference between control and plants applied with fertilizers up to 40:40:40 $N:P_2O_5:K_2O$ kg/ha but plants that received 80:80:80 $N:P_2O_5:K_2O$ kg/ha yielded the highest *Aloe* Juice. The recovery of *Aloe* juice ranged from 0.050 to 0.066% (Table 1).

Table 1. Effect of NPK fertilizers on recovery of *Aloe* juice from leaves of *Aloe vera*.

Treatment	No. of leaves	Fresh weight of plant(g)	Yield of *Aloe* juice(g)	Yield of *Aloe* juice normalized to 2000g F.W.	Recovery of *Aloe* juice on dry weight (%)
Control	14[a]	2268[a]	1.220[a]	1.075[a]	0.050[a]
10:10:10	14[a]	2198[a]	1.150[a]	1.046[a]	0.052[a]
20:20:20	14[a]	2352[a]	1.380[a]	1.173[a]	0.058[a]
40:40:40	14[a]	2576[a]	1.410[b]	1.095[a]	0.054[a]
80:80:80	14[a]	2632[a]	1.760[c]	1.337[b]	0.066[a]

Values of same alphabet indicate no significant difference between two treatment means at P<0.05

Table 2. Effect of NPK fertilizers on total polysaccharides in *Aloe* gel.

Treatment	Fresh weight of leaf (g)	Gel yield (g)	Dry weight of gel (g)	Total polysaccharides (Fresh weight basis) (g)	Total polysaccharides (g) (Dry weight basis)
Control	100	56.17[a]	2.17[a]	0.52[a]	0.020[a]
10:10:10	100	59.18[a]	2.29[a]	0.56[a]	0.022[a]
20:20:20	100	58.19[a]	2.29[a]	0.59[a]	0.023[a]
40:40:40	100	62.98[a]	2.38[a]	0.89[b]	0.034[b]
80:80:80	100	60.85[a]	2.38[a]	0.80[b]	0.031[b]

Values of same alphabet indicate no significant difference between two treatment means at P<0.05

Table 3. Effect of NPK fertilizers on active principles (%) in *Aloe* juice

Treatment	Free o-glycones	o-glycosides	c-glycosides	Anhydrous barbaloin	Hydroxy anthraquinone derivatives
Control	0.113[a]	0.072[a]	22.90[a]	23.35[a]	47.00[a]
10:10:10	0.089[a]	0.090[a]	22.82[a]	23.10[a]	46.20[a]
20:20:20	0.103[a]	0.103[b]	22.44[a]	22.75[a]	46.40[a]
40:40:40	0.118[a]	0.087[a]	27.10[b]	27.50[b]	62.00[b]
80:80:80	0.103[a]	0.083[a]	28.65[b]	28.90[b]	64.80[b]

Values of same alphabet indicate no significant difference between two treatment means at P<0.05

Table 4. Effect of NPK fertilizers on phenolic constituents (%) in *Aloe* juice using HPLC techniques

Treatment	Anhydrous barbaloin	*Aloe* emodin	Aloesin
Control	22.30[a]	Absent	11.10[a]
10:10:10	21.00[a]	Absent	12.70[a]
20:20:20	23.50[a]	Absent	10.60[a]
40:40:40.	25.80[a]	Absent	12.00[a]
80:80:80	30.00[b]	Absent	13.10[a]

Values of same alphabet indicate no significant difference between two treatment means at P<0.05

3.2 Effect of fertilizers on total polysaccharides of gel

Effect of NPK fertilizers on yield of gel and polysaccharides from the succulent leaf pulp (gel) was assessed. It was found that Aloe gel recovery on fresh weight basis ranged from 56.17 to 62.98% and on dry weight basis from 2.17 to 2.38% which did not differ significantly across treatments with various levels of fertilizers or no fertilizers. However level of NPK fertilizers did affect the quality parameters such as polysaccharides of gel. The total polysaccharides content ranged from 0.52 to 0.89% on fresh weight basis and 0.020 to 0.034% on dry weight basis. It was observed that the plants received up to 20:20:20 did not record any increase in polysaccharides but plants that received 40:40:40 or 80:80:80 N:P_2O_5:K_2O kg/ha recorded higher polysaccharides content (Table 2). Several authors (3, 11) have suggested that the yield of fresh and dry gel can be considered as parameters for gel quality. But our study has clearly demonstrated that yield of gel cannot be considered as a parameter since although the fresh or dry weight of aloe gel remained same in control and fertilizers applied plots the other parameters such as polysachharides, o-glycosides, c-glycosides, anhydrous barbaloin and hydroxy anthraquinone derivatives varied significantly. Hence we propose that estimation of all these parameters is essential for deciding the quality parameters of gel.

3.3 Effect of fertilizers on active principles

Effect of fertilizers on active principles was assessed. It was found that free c-glycones ranged from 0.089 to 0.118% but were not affected by the application of fertilizers. Similarly o-glycosides also ranged from 0.072 to 0.103% but there was no result trend and we may conclude that there was no effect of fertilizers on this active principle. However the concentration of c-glycosides, anhydrous barboloin and hydroxy anthraquinone derivatives were significantly affected with higher dose of application of fertilizers (40:40:40 and 80:80:80 N:P_2O_5:K_2O kg/ha). The application of fertilizers up to 20:20:20 did not affect the c-glycones, anhydrous barbaloin and hydroxy anthraquinone derivatives (Table 3). Farooqi and his co-workers (12) have proposed that the plant can be harvested from plant age of 8 months onwards. Our results have indicated that plants aged 12 months and above would give economical yield rather than from 8 or 9 months old plant (data not included).

3.4 Effect of fertilizers on phenolic constituents of Aloe Juice

Phenolic constituents such as anhydrous barbaloin, aloe emodin and aloesin were estimated using HPLC techniques. Anhydrous barbaloin estimated using colorimetric methods and HPLC methods were comparable, with acceptable experimental errors. It was found that Aloe emodin was absent in all the samples of Aloe juice irrespective of fertilizers treatment received. Thus it could be concluded that *Aloe* emodin was absent at inflorescence stage of the plant. The aloesin content was found to range between 10.60 to 13.10% but without any significant difference across treatments (Table 4).

4. Conclusions

Based on the above study it may be suggested that the yield of Aloe juice was higher at higher levels of applied nutrients suggesting that the herb responds positively to the applied nutrients. The yield of polysaccharides from *Aloe* gel was higher from the plants that received higher nutrients. The yield of c-glycosides, anhydrous barbaloin, hydroxy anthraquinone derivatives and aloesin contents were found to be the highest in 80:80:80 N:P_2O_5:K_2O kg/ha. *Aloe* emodin was totally absent in these plants suggesting that production of *Aloe* emodin would start only after this juvenile stage of the plant.

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