COLLECTION, CHARACTERIZATION AND EVALUATION OF *Aloe vera* (L.) Burm. f. GERMPLASM

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DECLARATION

I hereby declare that this thesis entitled **"Collection, characterization and evaluation of *Aloe vera* (L.) Brum. f. germplasm"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title of any other university or society.

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CERTIFICATE

Certified that this thesis entitled **"Collection, characterization and evaluation of *Aloe vera* (L.) Brum. f. germplasm"** is a record of research work done independently by Mrs. Abhila. S.R (2005-12-102) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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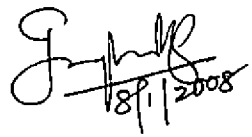

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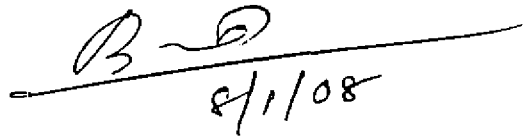

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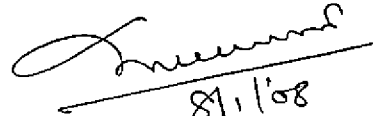

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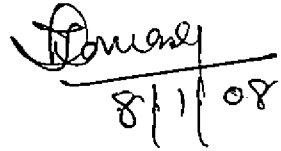

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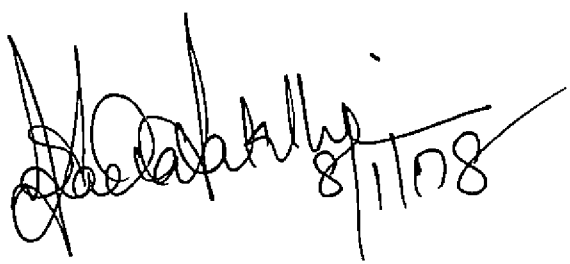

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List of Abbreviations

@	at the rate of
Ca	Calcium
cm	centimeter
CD	Critical Difference
et al	and others
Fe	Iron
Fig	Figure
FYM	Farm Yard Manure
g	gram
mg	milligram
µ g	microgram
µ m	micro meter
ha	hectare
K	Potassium
Kg ha^{-1}	kilo gram per hectare
m^2	square meter
mm^{-2}	Per square millimeter
Mg	Magnesium
MSL	Mean Sea Level
Na	Sodium
N	Nitrogen
P	Phosphorus
Plants ha^{-1}	plants per hectare
ppm	Parts per million
%	percent
t	tonnes
t ha^{-1}	tonnes per hectare
^{o}C	Degree Celsius

Introduction

1. INTRODUCTION

Aloe (*Aloe vera* (L.) Burm.f, Syn. *Aloe barbadensis* Miller) is an important medicinal plant belonging to the family Liliaceae. The plant yields two therapeutic substances, the translucent gel from inner portion of leaves and an yellow leaf exudate called latex. Its latex and leaf extract have been in use in traditional medicine for over two centuries. The leaf gel possesses properties such as anti-oxidant, anti-diabetic, anti-cancerous, anti-ageing, immunostimulant and general tonic effect. Based on these properties a number of formulations are available in the market, as medicines, skin care cosmetics and neutraceuticals.

Aloe genus comprises of about 200 species, indigenous to East and South Africa. However, only two species are grown commercially, *Aloe vera* (L). Burm.f. and *Aloe arborescence.* A number of species have been introduced in to India which grows in varied climates and different types of soils. The Sanskrit synonym *'Tarumi'* indicates evergreen nature of the plant as well as its property of keeping ever fresh and the Tamil synonym *'kumari'* describes the non-fruiting tendency of the species.

Aloe is a perennial plant that generally grows close to the ground in typical rosette shape. The plant has strongly cuticularised succulent, pale green, sword shaped leaves having spiny margin. It is widely cultivated in China, U.S.A, Mexico, Australia and some Latin American countries. Latin American countries are the major producers and exporters of aloe products. In India, aloe is commercially cultivated in Alwar in Rajasthan, Satanapalli in Andhra Pradesh, Rajpipla in Gujarat and some parts of Tamil Nadu.

Aloe has wide adaptability and can grow in various agro climatic conditions. The plant flourishes well in localities with lower annual rainfall of 50-300 mm and partial shade. In well-drained coarse sandy loam soils it grows well with high leaf yield. It is a crop having much demand by the pharmaceutical as well as cosmetic industry.

Tremendous morphological variability characters such as yield, leaf colour and size exist in most of the biotypes from Kerala and Tamil Nadu; but so far no

released varieties are available for commercial cultivation. Assessing the variability for desirable characters is a pre-requisite for any crop improvement programme. Hence collection, characterization and evaluation of aloe variability deserve utmost priority. Information generated through morphological, biochemical and anatomical studies will give a comprehensive picture on the diversity and relatedness of land races in aloe. The characterization of accessions of aloe would help us to determine the extent of variability available in the germplasm of this crop, which in turn would be helpful in identifying superior genotypes for yield and quality. The selection indices studies would facilitate effective selection and simultaneous improvement of one or more yield and quality contributing characters.

The present study was hence carried out with the following objectives:

To characterize the aloe germplasm collected from various geographical conditions, based on morphological, anatomical and biochemical variability and select promising ecotypes.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Aloe vera (L) Burm.f. is one of the most popular and widely used medicinal plant in pharmaceuticals, cosmaceuticals and neutraceuticals. It is a well-known medicinal plant of India and is one of the worlds most demanded crop. It is naturalized throughout the country, more common along the west coast (Robert and Hentry, 2004). Plants of the genus *Aloe* belong to old world and are indigenous to eastern and southern Africa. Genus *Aloe* is found in the tropics and was introduced to India for ornamental and medicinal purpose. The present study involves collection, characterization and evaluation of aloe germplasm using morphological, biochemical and anatomical variability and the following pages provides pertinent literature on the research carried out in this area as well as on related aspects.

2.1 GERMPLASM COLLECTION, CONSERVATION AND EVALUATION

Genetic resources are the building blocks of any breeding and improvement programme. Chomchalow (1980) reported the importance of genetic resources in the improvement of medicinal plants. The species presently used for cultivation are only a small part of a whole diversity present in the world. Hence, germplasm collection, evaluation, characterization and documentation are of special importance and great significance for the utilization and conservation (Chomchalow, 1993; Gupta et al., 1988; Bista, 1988; Latif, 1989). The success of any breeding programme depends largely on the extend of genetic variability available in a breeding population. Pooling of desirable gene in to the adapted types is always considered as the thrust area. Genetic erosion is quite rampant in the region due to change in land pattern, cropping pattern, and habitat destruction. Hence there is an urgent need to collect and conserve this genetic wealth which otherwise may be lost forever.

Dhar and Bhat (1982) carried out an evaluation of *Atropa belladonna* for alkaloid content, herbage yield, height and tillering and found significant

differences in all characters studied. A systematic germplasm evaluation for an alkaloid profile was carried out in India by Srivastava et al. (1990) and identified strains containing very high morphine alkaloid content in *Papaver somniferum*.

Pareek and Maheshwari (1990) collected sixteen cultivars of palmrosa from North Indian states and selection of superior cultivars was made based on higher herbage yield, essential oil, and geraniol content. Prasanna et al. (1994) evaluated five genotypes in marjoram to assess the range of variability and character association with respect to yield and yield attributing traits and observed that total herbage yield was positively correlated with plant height, plant spread, fresh weight of herb, dry weight of spike and total dry weight of whole plant.

Presanna et al. (1994) observed that geographical races of *Kaempferia galanga* differed significantly in quantum yield of rhizome and oil. He also observed that oil quality remained the same irrespective of the geographical type.

Wide variability was observed in lemon grass (*Cymbopogon flexuosus*) for characters like grass yield, oil yield, oil content, citral percentage, length of culm, length and breadth of lamina and colour of leaf sheath when four hundred and four accessions were evaluated for morphological and yield characters (Kuriakose, 1995)

Among one eighty species of genus *Aloe*, some are arborescent and others are herbs (Sharma et al., 1996). Twelve genotypes of lemongrass (*Cymbopogon flexuosus* L. Stapf) were evaluated for genetic variability among genotypes for morphological characters and maximum range of variability was observed for fresh weight of herb followed by oil yield and plant height (Singh and Singh, 1999). A detailed evaluation of genetic stocks of *Clitoria ternatea* for yield, alkaloid content and nitrogen fixing potential revealed that thirteen accessions differed significantly in plant length, number of leaves, leaf area, number of pods per plant, leaf weight and seed alkaloid content (Nair, 2000).

A similar study conducted in *Mucuna pruriens* by Samuel (2000) also recorded significant differences in plant length, number of leaves, number of pods

per cluster, leaf weight, shoot weight, biomass yield and number of effective nodules of the ten accessions collected.

Sarada (2000) discussed the need for evolving suitable strategies for sustainably utilizing the medicinal plant resources, occurring as indigenous or naturalized with in the oil palm plantations and their vicinity.

Germplasm collection and evaluation of aloe was conducted by Singh et al. (2005) to provide a genetically defined planting material to the growers.

2.2 VARIABILITY

Populations obtained from native habitats have shown variability in active compounds. Variability is even seen in commercially selected materials and it is believed that these are the products of random selection. In these materials the inheritance of active principles is not guaranteed (Haq, 1995). Farooqi et al. (1990) reported that from among the eleven genotypes of *Artemisia pallens* Wall. significant variation occurred for characters like plant height and oil content. Singh et al. (1999) observed high genetic variance in seven collections of *Mentha spicata* L. from North India. He also reported high heritability and genetic gain, which indicate additive genetic effect and hence suggested these characters could be considered for crop improvement through selection.

Prasad et al. (1998) collected fifteen ginger cultivars from different states of India to study variability and association of characters among themselves. It was revealed that high coefficient of variability was observed for number of leaves and tillers. Moderate to low variability was noticed for length and breadth of rhizome, breadth of leaf, number of primary fingers, and rhizome weight per plant, number of secondary fingers, plant height and length of leaf. Plant height, length of leaf, breadth of leaf, number of primary fingers, length and breadth of rhizome had positive and significant correlation with yield. A negative and significant correlation existed between yield and number of tillers

Misra et al. (1998) reported that highest phenotypic and genotypic coefficient of variation was recorded for dry root yield followed by plant canopy and the lowest for plant height in ashwagandha (*Withania somnifera*).

Singh et al. (2000) reported that significant variation among genotypes were recorded for the characters such as plant height, number of leaves per plant and number of branches per plant in opium poppy. The yield was positively and significantly associated with number of leaves per plant and number of branches per plant.

Twelve qualitative characteristics of fifteen fenugreek genotypes were studied for effective selection of important characters for higher yield by Das and Kole (2001). Mishra et al. (2001) observed large differences among 32 accessions of periwinkle collected from different geographical areas of India, Madagascar, Singapore and Malaysia. Strong correlation was observed between leaf area and leaf yield.

Krishnamoorthy and Madalageri (2002) conducted studies to assess the range of variability and character associated with growth, yield and yield attributing traits in fifteen genotypes of ajowan (*Tachyspermum ammi*). Mulas et al. (2002) observed a positive correlation between leaf width and shoot fresh weight in rosemary (*Rosemarinus officinalis* L.) cultivars. Lal et al. (2003) observed tremendous variability in quantitative traits such as days to flower, leaf length, main stem diameter and branches per plant among genetic stocks in curry neem (*Murraya koeningii*).

Shivaprasad et al. (2003) made comparative analysis of anhydrous barbaloin, free aglycone, O-glycoside, C-glycoside and hydroxyanthraquinones in *Aloe vera* and reported that samples collected from Karnataka and Kerala are superior in quality when compared to those collected from Tamil Nadu and Andhra Pradesh.

Pilania et al. (2005) observed wide range of variations and fluctuations in herbage yield and yield contributing characters among ten accessions of French

basil comprising of indigenous as well as exotic germplasm planted under stress environment of NBPGR, Issapur.

2.3 INFLUENCE OF ECOLOGICAL FACTORS IN THE PHYSICOCHEMICAL CHARACTERIZATION OF MEDICINAL PLANTS

Plants grow equally well in different regions but may or may not produce the active constituents in the same concentrations. Tetenyi (1992) reported that chemical changes and intraspecific chemical modifications may take place in medicinal plants due to ecological and geographic conditions. Jaggi and Kapoor (1997) reported about such variations in *Solanum* species growing outside India. The fruits of *Solanum xanthocarpum* from Nepal contained higher solasodine content (1.6%) than from France. In India, berries of *S. khasianum* collected from Nilgris showed maximum amount of solasodine.

Ramamurti (2002) suggested the case of *Aloe barbadensis*, which has been studied under all geographical regions for its principal active ingredients, namely aloin and anthraquinone. Under Indian conditions, different populations of *Aloe barbadensis* showed variation in aloin content ranging from 5.53 to 22.7% of dry extracts of the exudates. Maximum concentration of aloin was obtained during summer months.

Massiah et al. (1998) studied the effect of N, P, K, Ca and Mg deficiencies on the dimensions and coloration of leaves of aloe grown in sand and found that leaf length, width, thickness and weight showed the highest values in plants receiving complete nutrient solution and lowest values in plants receiving solutions with out nitrogen or water only.

Purohit et al. (1999) studied the variation in podophylloresin and podophyllotoxin contents in different populations of Indian podophyllum (*Podophyllum hexandrum*). The concentration of both resin as well as toxin contents varied in different populations, highest being in the populations collected from alpine regions. The quantities of the resin and toxin contents were high during May-June compared to that in September – October.

Lawrence (1976) found that the Brazilian oil of Japanese mint contained relatively high proportion of limonene; where as oil from Japan had high octoniol content and piperitone content. The Korean oil has characteristically high caryophyllene content. The composition of these minor aroma compounds in the oil determines the geographical region of the oil traded. Mallavarpu et al. (1989) carried out investigation on the essential oil of cinnamon leaf grown at Bangalore and Hyderabad. Besides the main constituent eugenol (81.4 – 84.5%), 47 other constituents, including those present in trace amounts have been identified in the oil samples from the two locations. The two samples differed with respect to the relative amounts of linalool, cinnamaldehyde, cinnamyl acetate, and betacaryophyllene and benzyl benzoate. Also oil content of Hyderabad material was found to be higher than that of the Bangalore material.

According to Gupta and Chadha (1995), the French lavender cultivars provide example were local cultivation produce large amount of linalyl acetate and higher linalool content in the oil than the one grown in Bulgaria. These cultivars grown in Brazil produced oil containing high percentage of bornyl acetate (45%) and were deficient in linalyl acetate. The oil of rose provides yet another example of this phenomenon involving culture and location interaction. The oil produced in sodic soils of Banthra is quite comparable to that of Bulgarian rose oil (Gupta and Chanda, 1985).

Considerable difference were found by Wallart et al. (2000) in the contents of artemisinin, artemisinic acid and dihydroartemisinic acid between *Artemisia annua* of different plants of different geographic origin. The highest levels of dihydroartemisinic acid and artemisinin were measured in the *A. annua* plants of Vietnamese origin, while the lowest levels of these two compounds were found among the Chinese and European *A. annua.*

2.4 MORPHOLOGICAL CHARACTERIZATION

The morphological characters can be misleading for a medicinal and aromatic plant breeding programme unless these characters are correlated with the yield and quality of the medicinal and aromatic compounds (Haq, 1995). Levy et

al. (1983) studied the development of vegetative yield components and ajmalicine content in the roots of pure lines of *Catharanthus roseus* and their hybrids. The F_1 hybrids performed better than the parents in leaf and root weight and significant correlations were found between them but not between vegetative components and ajmalicine content. Variability in biometric characters like plant height, spread of plant, length of leaf, breadth of leaf, leaf thickness, weight of leaf, leaf shape, leaf color, phyllocrone and suckering were studied by several workers in aloe. Crop yield, a complex character is determined by various yield components (Singh, 1983).

Morphological characterization of aloe germplasm has been carried out by several workers. Farooqi and Sreeramu (2001) reported that the fleshy leaves are about 60 cm long 10 cm broad and 1.5 to 2 cm thick. Bhattacharjee (2004) reported that leaves are 50 cm long and 8 cm wide. Singh et al. (2005) reported that height of aloe varies from 36 cm to 62.53 cm, the thickness of leaf varied from 2.83 to 6.83 cm, weight of leaf varied from 37.97 g. to 201.14 g., the number of suckers varied from 3.33 to 8.53.

2.5 ANATOMICAL CHARACTERIZATION

Adaptation to different environmental conditions usually result in extreme modification of organs particularly those of vegetative body. In order to get detailed information about the population, diagnostic characters other than gross morphology are needed. Leaf anatomical characters have been used extensively in taxonomic and phylogenetic studies because they are very informative and reliable.

Gahreman et al. (1998) reported that stomatal occurrence and stomatal index are the most useful anatomical characters for taxonomic purpose. According to Edeoga (2001) eight wild species of Dioscorea could be differentiated based on the difference in foliar epidermal cells, trichomes, vascular bundle structure and stomatal size, shape and index. The morphology of epidermal cell walls, nature and number of epidermal cells per unit area, stomatal frequency and stomatal

index were identified as useful parameters for differentiation of twelve species of zingiberaceae (Gogoi et al., 2002).

Ni et al. (2004) reported that the pulp of *Aloe vera* consisted of large clear mesophyll cells with a diameter as large as 1000 micron in light and electron microscopy. Ravikumar et al. (2005) opined that histological studies could be an effective tool to assess chemical constituents of cells in *Coleus forskohlii.*

Baruah and Nath (2002) studied micro morphological characters namely the epidermal and veination character of two variants of *Cinnamomum parthenoxylon* and recorded number of remarkable variation in quantitative data for variants.

Morphological and anatomical characters of *Scutellaria orientalis* L. subsp. *bornmuelleri* Hausskn ex Bornm were examined and results were compared with other allied taxa of *Labiatae.* The study revealed that anatomical characters provide good taxonomic clues to distinguish taxa at different levels (Ozdemir and Altan, 2007)

Alex (2005) reported variations in number of stomata among various accessions of Kasthuri turmeric but were found to be very insignificant to distinguish them based on this character.

2.6 BIOCHEMICAL CHARACTERIZATION

The evaluation of contents of active principles in a given environment is a pre-requisite for medicinal and aromatic plant breeding. The pharmaceutical and aromatic industries give priority to high quality which may be produced from a small number of plants over the higher yield obtained from a larger number of plants as the latter may produce some variance in quality (Haq, 1995). Active substances and other chemical properties are different from population to population. However, selection of individuals from populations on the basis of compositions of chemicals can provide a uniform variety (Haq, 1995).

The contemporary literature in agrotechnology of several medicinal and aromatic plants demonstrates the fact that plant varieties with an abundance of desired constituents can be reproduced and improved upon under cultivation

even in an alien habitat (Franz, 1990). *Hyoscyamus muticus*, which grows wild in Egyptian deserts, is used as a source of tropane alkaloids. CSIR (1982) reported that attempts to cultivate *H. muticus* resulted in plants with lower alkaloid content. Raina (1996) reported that irrigation has the greatest effect on the gel composition in aloe, so irrigation control could aid in standardizing the gel composition. Kurian et al. (2000) observed that the nature and content of both primary and secondary metabolites of pepper (*Piper nigrum*) and *kurumthotti* (*Sida rhombifolia*) varied with the change of habitat from wild to domestic.

Paez et al. (2000) investigated the effects of light on growth, carbon allocations and concentration of organic solutes, including carbohydrates and aloin in *Aloe vera*. Plants were vegetative propagated; dry matter of plants grown under deep shade was higher compared to those grown in full sunlight and no significant variation on carbohydrate concentration and aloin content was noticed under different irradiance level.

Yaron (1993) stated that the polysaccharides constituted 0.20 – 0.30 % of fresh aloe gel and 0.80 - 1.20 % of dry matter content. The other constituents like free aglycone, O-glycosides, c- glucosides and hydroxyl anthraquinones were estimated by Shivprasad et al. (2003).

Azarn and Kumar (2000) reported that the similar looking Meetha and Khara varieties of *Aloe vera* collected from the same fields of Rajasthan showed significant variation in aloin content, pungent odour and storage life.

Lyophilized *Aloe vera* juice on neutron activation analysis was found to contain calcium (4.70%), sodium (1.43 %), potassium (6.60 %), chloride (12.20 %) and manganese (0.01 %) (Handa and Kaul, 1996).

Raina (1996) reported the presence of highest content of total nitrogen (1.47%), protein nitrogen (1.22 %), total protein (9.54 %) and real protein (7.63 %) in *Aloe vera* leaves sampled in April; the highest content of aloin (4.31 %) and free amino acids (798.17 mg $100g^{-1}$ leaves) in July. Samples collected in

January had the lowest amount of components and the leaves of upper region were comparatively poor in chemical constituents. Analysis of dry mass obtained from aqueous extract of fresh leaves of three-year-old *A. arborescens* showed 6.30 % total protein, 3.47 % non-protein substance containing nitrogen and 0.60 % free amino acids. The pulp of the leaves were found to contain sugars, glucose, galactose, mannose and galacturonic acid.

Total free amino acid in plant tissue indicated physiological health status of tissue (Sadasivam and Manickam, 1992). Uday et al., (2002) reported a decrease in free aminoacid under salinity in Isobagol and Lentil. The total soluble free amino acids level rose as water stress increased in three species of *Pices mariana*, White spruce, Jack and Pine. Drought stress caused organ specific increase in free amino acids in *Populus tremuloids* (Griffin et al., 1991). The mucilaginous gel extracted from fillets of *Aloe vera* was characterized by Feminia et al. (1999) and reported that mannose (19.5%) and cellulosic glucose were the major polysaccharide components and acemannan was a reserve polysaccharide.

Hu et al. (2003) reported that the antioxidant activity of *Aloe vera* extracts followed the order: three-year-old *Aloe vera* > four-year-old *Aloe vera* > two-year-old *Aloe vera.* The three-year-old extract exhibited the strongest radical scavenging activity and suggested that growth stage plays a vital role in the composition and antioxidant activity of *Aloe vera.*

Bonner (1988) reported that peroxidase is one of the key enzymes involved in disease resistance in plants. It has got an important role in the biosynthesis of lignin. Peroxidase isoenzymes play an important role in eliminating H_2O_2 and are distributed in at least four distinct cell compartments, the stroma and thylakoid in chloroplasts, and microbody in cytosol. Macko et al. (1968) found that enzyme PO itself is toxic to many pathogens. The increased peroxidase activity was reported in water stressed marigold (Kurup et al., 1994) and the same reported in cucumber (Yang et al., 2000). An increase of peroxidase activity was noticed in salt grown *Lycopersicon pennelli* (Shalata and Tal, 1998).

Pharmacology, pharmacognosy, clinical studies and phytochemistry of aloe gel were reviewed by Reynolds and Dweek (1999).

Twenty-one aminoacids, vitamins like A, C and E, minerals like Na, K, Ca, Mg, Fe, Zn, enzymes like peroxidase, polyphenol oxidase and lipase activity noticed suggested the anti oxidant property and the role in skin protection activity of *Aloe vera* (Esteban et al., 2000). These act as antioxidants against oxidative stress, scavenge free radicals and act as saviors of cell (Gajera et al., 2004). A glycoprotein with normal human dermal cell proliferation promoting activity, designated verectin, was isolated from *Aloe vera* gel. Verectin was detected in unpasteurized samples of commercial gel powders (0.01-0.07 ug/ug) and remain stable for at least four years at 4°C under desiccative conditions (Yagi et al., 2000).

A basic peroxidase (EC 1.11.1.7) (pH around 9.0) had been identified in commercial gel of *Aloe barbadensis*. In vivo, the activity was localized in the vascular system of inner aqueous leaf parenchyma (Esteban et al. 2001).

Kosuge (1969) reported that polyphenol oxidase is a copper-containing enzyme that oxidized phenolics to highly toxic quinines and involved in the terminal oxidation of diseased plant tissue. This is attributed to the role of disease resistance in plants. Polyphenol oxidase activity was inhibited in Aswaganda under fluoride as a soil pollutant. (Vyas and Mavani, 2001)

The oxidative enzymes catalase, peroxidase and polyphenol oxidase activity increased up to optimum levels and thereafter all these gradually declined in *Salicornia brachiata* under different levels of exogenous addition of NaCl (Manikandan and Venkitaswar, 2003).

2.7 ETHNOBOTANIC STUDIES

Ethno botanical research are gaining world wide attention now a days as the people are moving after herbal products which are considered as comparatively safe with less side effects. This area of research gives leads to the development of products particularly in the field of pharmaceuticals and

neutraceuticals. Most knowledge and experience with traditional medicine exist in oral form with local tribal or ethnic group, so it is essential to record this information as soon as possible. This knowledge will provide the guidelines for potentially useful species and their utilization for the medicinal and aromatic industries. Gupta et al. (1988) suggested that evaluation should be given priority, and descriptor- characters have to be prepared for evaluation of medicinal and aromatic plants.

India has over 550 tribal communities that come under 227 linguistic groups. Two thirds of tribal population is concentrated in Madhyapradesh, Orissa, Bihar, Gujarat and Rajasthan (Pushpangathan, 1994). Even though the term ethno botany seems to cover only the plant related areas of ethnic studies, many recent ethnobotanists include ethno medicines and ethno pharmacology also under ethno botany. Pushpangathan and Nair (2003) reported about 200 plant species in Kerala as ethno medically important. The Western Ghats forest of Kerala and the tribal communities inhabiting in and around this region is a treasure house of ethno botanical wisdom (Radhakrishnan, 2004). Shivaprasad and Chandrashekar (2003) reported the use of aloe leaf pulp against jaundice by *nadivydyas* in south Karnataka.

Bhatt et al. (1999) reported that in Chetrunjaya hill of Palitana, Gujarat the linguistic name of aloe is Kunwar and the pulp of leaf applied on swellings, burns, boils and piles; also given orally in sunstroke and for improving digestion. Observation on ethnoveterinary herbal practices in Gujarat revealed that the pulp of aloe along with salt and turmeric powder could cure swelling, mastitis and wounds in animals (Bhatt et al., 2001).

Some tribal and rural communities of Pachmarhi forest (Madhyapradesh) use aloe pulp for burns on the body and is known as Guarpatha in their local language (Katewa et al., 2001). Bhatt et al. (2003) reported that paste of leaf pulp is applied on burns, blund injury and piles in Pachchham hills of Kachchh district, Gujarat and it is linguistically known as Kunwar. Sen et al., (2000) reported that Gwarpatha or aloe is used against 'eye flu'.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The experiment titled "Collection, characterization and evaluation of *Aloe vera* (L.) Burm.f. germplasm" was conducted at the Department of Plantation crops and Spices, College of Agriculture, Vellayani, during the period 2006 – 2007. The experimental site is located at 8° 5' N latitude and 77° 1' E longitude at an altitude of 29 m above mean sea level.

Field visits were conducted at various locations of Kerala and Tamilnadu, to collect the germplasm. Thirty diverse accessions of aloe were collected from different parts of Kerala and TamilNadu. Relevant details on habit, habitat, local use (collection of ethno-botanical information and information based on traditional practices) and special features (if any), of the accessions were collected. Preliminary evaluation of reference sample plants of each accession were done in terms of morphological and biochemical characters. The collected accessions were planted in clay pots filled with potting medium consisting of sand, soil and dried powdered cow dung in the ratio 1:1:1 (Plate 1). A final evaluation of morphological, anatomical and biochemical characters were carried out one year after planting in the new environment. The details of the accessions and their source are given in Table 1.

The experiment was laid out in CRD with five replications during April 2006 – March 2007.

3.1 MORPHOLOGICAL CHARACTERIZATION

Five plants from each accession were selected for recording morphological characters. Observations were recorded during April 2006 and March 2007.

3.1.1 Growth Characters

3.1.1.1 *Plant height*

Height of plant was measured from ground level to the top most leaves of all observational plants, mean worked out and expressed in centimeters.

Table 1. Particulars of *Aloe vera* accessions used for the study and their sources

Sl. No.	Accession Number	Source
1.	AV-1	Thodupuzha, Ernakulam.
2.	AV-2	Ambalavayal, Wynad.
3.	AV-3	Ranni, Pathanamthitta.
4.	AV-4	Kottayam.
5.	AV-5	Valliyur, Thirunelveli.
6.	AV-6	Kumily, Idukki.
7.	AV-7	Chalakudy, Thrissur.
8.	AV-8	Pechiparai, Kanyakumari.
9.	AV-9	Ochira, Alappuzha.
10.	AV-10	Kollam.
11.	AV-11	TNAU, Coimbatore.
12.	AV-12	Adimali, Idukki.
13.	AV-13	Sulthan bethary, Wynad.
14.	AV-14	Parasala, Neyyatinkara.
15.	AV-15	Pettah, Thiruvananthapuram.
16.	AV-16	Rajakad, Idukki.
17.	AV-17	Pathanapuram, Kollam.
18.	AV-18	Thenkashi, Thirunelveli.
19.	AV-19	Mothiramalai, Kanyakumari.
20.	AV-20	Krishnapuram, Kayamkulam.
21.	AV-21	Puliyankudi, Thuthukudi.
22.	AV-22	Alathur, Palakkad.
23.	AV-23	Madhurai.
24.	AV-24	Kaliyal, Kanyakumari.
25.	AV-25	Maniyankuzhi, Kanyakumari.
26.	AV-26	Marthandam, Kanyakumari.
27.	AV-27	Thirumangalam, Madurai.
28.	AV-28	Kambam,Theni.
29.	AV-29	Vellanad, Thiruvananthapuram.
30.	AV-30	Mannuthy, Thrissur.

Plate 1 Overall view of the experimental plants

Plate 1

3.1.1.2 *Spread of the plant*

The distance occupied by the plant in North – South and East- West direction from its axis was measured, mean worked out and expressed in square centimeters (Balakumbahan, 2004).

3.1.1.3 *Length of leaf*

The sixth leaf from the top of the sample plants was selected as the reference leaf for measuring the morphological parameters. The length of the leaf was measured from the base of leaf to the tip and expressed in centimeters.

3.1.1.4 *Breadth of leaf*

The maximum breadth of the reference leaf was measured from the basal portion of the leaf and expressed in centimeters.

3.1.1.5 *Leaf thickness*

The maximum thickness from the basal portion of the reference leaf was measured and expressed in centimeters.

3.1.1.6 *Weight of leaf*

Fresh weight of the reference leaf was measured and expressed in grams.

3.1.1.7 *Leaf shape*

The leaf shape was compared with the standard reference leaf and the difference noted.

3.1.1.8 *Leaf colour*

The leaf was observed for the presence or absence of white streaks or spots and the colour of the leaf were recorded based on the intensity of green colour, as light green, green and dark green.

3.1.1.9 *Phyllocrone*

It is the time taken for emergence of successive leaves. Number of leaves produced was noted at bimonthly interval to find out phyllocrone and was recorded in days.

3.1.1.10 *Suckering*

The number of suckers produced by the sample plants for one-year period was counted and expressed as number of suckers plant^{-1} year^{-1}.

3.1.2 Yield Characters

3.1.2.1 *Leaf yield*

Three cuttings were taken from each plant. First cutting was taken four months after planting and next two cuttings were taken at subsequent intervals of four months .The yield obtained per cutting was recorded and expressed in Kilograms plant^{-1} year^{-1}.

3.1.2.3 *Fresh latex yield*

The leaves after cutting at the basal portion are immediately transferred to a pre-weighed polyethylene cover and allowed to remain undisturbed for two hours. The latex weight per leaf was summed up and total latex weight was worked out and expressed in grams plant year^{-1}.

3.2 ANATOMICAL CHARACTERS

3.2.1. Number of Stomata

The number of stomata was recorded for upper surface of reference leaves from each replication. Leaf imprints were prepared for the purpose using the adhesive Quick fix. A thin film of Quick fix was applied over the selected leaves. The film was peeled off after few minutes and the number of stomatal impressions was counted using a compound microscope (100 x magnifications). The area of microscopic field was calculated using a stage micrometer and the number of stomata per unit area (mm-^{2}) was calculated and recorded (Taylor et al., 1997).

3.2.2 Cuticle Thickness (µm)

A very thin free hand cross-section of the reference leaves from each replication was taken and the cuticle thickness was observed using 40x objective and 10x eyepiece. The thickness of cuticle was measured with stage and ocular micrometers and expressed in micrometers.

3.2.3 Thickness of Epidermis (µm)

The thickness of epidermis was measured using stage and ocular micrometers and expressed in micrometers.

3.2.4 Thickness of Mesophyll (cm)

The mesophyll thickness was measured and expressed in centimeters.

3.3 BIOCHEMICAL CONSTITUENTS

3.3.1 Amino acids

The total free amino acid content of fresh leaf gel was estimated by the method developed by Sadasivam and Manickam (1992). One gram of homogenized leaf gel was used as sample. The amino acid content in the sample was expressed as milligram equivalent of leucine 100 $gram^{-1}$ fresh weight.

3.3.2 Sugars

The total sugar content of fresh gel was estimated by anthrone method of Sadasivam and Manickam (1992) and expressed as grams 100 $gram^{-1}$ fresh weight.

3.3.3 Fatty acids

The free fatty acid content of the gel was estimated by the method of Sadasivam and Manickam (1992) and expressed as milligram oleic acid 100 $gram^{-1}$ of fresh weight.

3.3.4 Vitamin A

Carotene content of fresh leaf gel was estimated by the method of Sadasivam and Manickam (1992). One gram of homogenized leaf gel was used as sample. The carotene values expressed in mg 100 $gram^{-1}$ fresh weights.

3.3.5 Ascorbic acid

Estimation of ascorbic acid was done as per the method described by Sadasivam and Manickam (1992) and expressed as mg 100 $gram^{-1}$ of fresh weight.

3.3.6 Saponins

Saponin content of fresh leaf gel at the time of planting and one year after planting was estimated according to the method proposed by Hudson et al. (1979).

Procedure :

Ten grams of the blended gel was mixed with 100 ml of 20 per cent aqueous ethanol in a beaker and agitated with a magnetic stirrer for 12 hours at 55° C. The solution was filtered using Whatman No.1 filter paper; the residue was

re-extracted with 200 ml of 20 per cent aqueous ethanol. The extracts were mixed and reduced to about 40 ml under vacuum. The extract and 20 ml diethyl ether were poured into a 250 ml separating funnel and shaken vigorously. The aqueous layer was discarded. The process of purification continued until a colorless aqueous extract was obtained. The pH of the remaining aqueous solution was adjusted to 4.5 by adding 4g of sodium chloride and the solution was shaken successively with 60 and 30 ml of n- butanol. The butanolic extract was washed twice with 10 ml of 5 per cent aqueous sodium chloride, and then evaporated to dryness in a fume cupboard, to give the saponin, which was weighed and expressed as percentage.

3.3.7 Minerals

Five grams of fresh homogenized leaf gel was used for estimating the minerals present in aloe gel. The procedures followed were as below:

Mineral	Method	Reference
Sodium and Potassium	Nitric-perchloric acid (9:1) digestion and flame photometry	Jackson (1958)
Iron	Nitric-perchloricacid (9:1) digestion and spectrophotometry	Jackson (1958)
Calcium and Magnesium	Nitric-perchloric acid (9:1) digestion and titration	Walton (1966)

3.3.8 Enzymes

3.3.8.1 *PO activity*

Peroxidase activity was determined according to the procedure described by Srivastava (1987). Leaf gel sample of 200 mg was homogenized in 1ml 0.1M sodium phosphate buffer (pH 6.5) to which a pinch of polyvinyl pyrollidine (PVP) was added. The homogenization was done at 4°C using a mortar and pestle. The homogenate was filtered through a muslin cloth and centrifuged at 5000 rpm for 15 minute at 4° C. The supernatant was used as the enzyme extract for the assay of PO activity.

The reaction mixture consisting of one ml 0.05 M pyrogallol and 50 µl enzyme extract was taken in both reference and sample cuvettes, mixed and kept in a spectrophotometer and reading was adjusted to zero at 420 nm. The enzyme reaction was started by adding one ml of one per cent of hydrogen peroxide in to sample cuvettes and change in absorbance was measured at 30-second intervals.

$$\text{PO activity (x)} = \frac{\text{absorbance at 180 sec} - \text{absorbance at 30 sec}}{2.3}$$

$$\text{PO activity (g min}^{-1}\text{)} = x \times \frac{1000 \times 1000}{50 \times 200}$$

3.3.8.2 ***Polyphenol oxidase activity*** **(PPO)**

PPO activity was determined as per the procedure given by Mayer and Anderson (1965). The enzyme extract was prepared as per the procedure given for the estimation of peroxidase.

The reaction mixture contained one ml of 0.1M sodium phosphate buffer (pH 6.5) and 50 µl of enzyme extract. The reaction was initiated after adding one ml of 0.01M catechol. The change in absorbance was recorded in spectrophotometer at 495 nm and PPO activity was expressed as change in absorbance of reaction mixture minute^{-1} gram^{-1} on fresh weight

$$\text{PPO activity (x)} = \frac{\text{absorbance at 180 sec} - \text{absorbance at 30 sec}}{2.3}$$

$$\text{PPO activity (g min}^{-1}\text{)} = \frac{x \times 1000 \times 1000}{50 \times 200}$$

3.4 STATISTICAL ANALYSIS

The experimental data was analysed as per Panse and Sukhatme (1985). Qualitative and quantitative characters of thirty accessions under trial were recorded before planting and one year after planting.

Analysis of variance was worked for all the traits to find out whether there was any significant difference between accessions in respect of various traits.

A correlation analysis was done to determine degree of association between different parameters as per Singh and Chaudhary (1936).

Student's t test was done to compare the difference between means of characters under study before and after the experiment (Singh and Chaudhary, 1936).

Selection indices were worked out through the application of selection index developed by Smith (1936) and based on discriminant function of Fisher (1936).

Separate selection index was worked out based on the following characters:

1) Morphological characters
2) Biochemical characters and
3) Morphological and biochemical characters.

RESULTS

4. RESULTS

The results of the study titled "Collection, characterization and evaluation of *Aloe vera* (L.) Burm.f. germplasm" are presented in this chapter

4.1. COLLECTION OF *Aloe vera* (syn. *Aloe barbadensis)* GERMPLASM

A total of 30 accessions and a minimum of five plants under each accession were collected from different regions of Kerala and Tamil Nadu. For this, field visits were conducted at various locations of Kerala and Tamil Nadu,. List of collected accessions with their sources is given in Table 1.

4.2. MORPHOLOGICAL CHARACTERIZATION

Data on morphological characters like plant height, plant spread, leaf length, leaf breadth, leaf thickness, leaf weight, leaf shape, leaf colour, phyllocrone and rate of suckering were recorded for each accession, statistically analysed and presented in Table 2

Statistical analysis of the data revealed that there was significant variation in the height of plants among accessions during the preliminary evaluation and one year after planting. The accession AV-2 recorded the highest height (68.90 cm) followed by AV-12 (68.20 cm). These values were statistically on par with the plant height of AV-6 (68.00 cm). The lowest plant height was shown by AV-25 (31.10 cm) during the initial observation. One year after planting also AV-2 recorded highest value for plant height (69.74 cm) followed by AV-6 (68.48 cm) and AV-12 (68.00 cm), which were statistically on par, while the lowest plant height and was for AV-25 (32.70 cm).

The plant spread showed significant difference in the initial and final observations. It was highest for AV-2 for both observations and was respectively 0.988 m^2 and 1.101 m^2 and was the lowest for AV-25 in both observations and was respectively 0.304 m^2 and 0.318 m^2.

The data on variation of leaf length of the accessions are presented in Table 2. The accession AV-2 (51.00 cm) recorded maximum leaf length and was

Table 2. Variation in morphological parameters of *Aloe vera* accessions during the initial and final observations (Mean of 5 replications)

Accession	Plant height (initial) cm	Plant height (1 YAP) cm	Plant spread (initial) m²	Plant spread (1 YAP) m²	Leaf length (Initial) cm	Leaf (1 YAP) cm length	Leaf breadth (Initial) cm	Leaf breadth (1 YAP) cm	Leaf thickness (Initial) cm	Leaf thickness (1 YAP) cm	Leaf weight (Initial) g	Leaf weight 1 (YAP) g
AV-1	38.00	38.74	0.474	0.498	39.16	40.46	5.40	5.40	1.38	1.32	109.00	106.20
AV-2	68.90	69.74	0.988	1.101	51.00	50.26	7.18	7.12	1.72	1.76	195.00	192.70
AV-3	48.50	50.66	0.632	0.662	34.94	35.60	5.28	5.38	1.38	1.56	92.20	93.80
AV-4	51.52	51.80	0.502	0.514	35.50	35.58	5.68	5.26	1.26	1.40	91.80	93.40
AV-5	38.90	38.84	0.386	0.408	33.20	34.50	5.30	5.44	1.14	1.28	66.80	70.20
AV-6	68.00	68.48	0.750	0.754	48.04	47.16	7.06	7.14	1.26	1.32	125.00	125.00
AV-7	48.68	50.34	0.647	0.658	40.44	41.2	6.06	6.16	1.32	1.38	125.20	126.80
AV-8	48.60	49.78	0.716	0.734	42.60	42.74	5.38	5.34	1.28	1.46	88.00	87.20
AV-9	52.86	54.00	0.716	0.718	41.70	42.38	6.66	6.78	1.08	1.34	135.80	131.40
AV-10	51.48	53.38	0.658	0.668	40.06	40.40	6.10	6.22	1.04	1.24	104.00	109.00
AV-11	40.88	40.96	0.350	0.368	33.32	34.44	5.60	5.48	0.94	1.12	82.00	83.00
AV-12	68.20	68.00	0.717	0.722	48.02	47.76	7.06	7.14	1.10	1.20	143.00	147.80
AV-13	55.20	53.34	0.712	0.713	47.54	46.78	6.56	6.80	1.18	1.24	158.80	162.00
AV-14	51.00	52.06	0.644	0.650	43.10	45.14	6.44	6.50	1.24	1.32	106.00	111.80
AV-15	55.70	57.20	0.762	0.764	47.70	47.30	5.76	5.90	1.24	1.30	139.80	142.40
AV-16	62.28	63.96	0.736	0.738	46.60	47.50	6.76	6.88	1.24	1.28	166.00	161.40
AV-17	47.10	50.48	0.600	0.608	41.10	41.90	5.98	6.00	1.10	1.22	118.60	119.80
AV-18	36.50	37.16	0.398	0.416	33.00	34.30	4.60	4.54	0.84	0.84	59.00	61.00
AV-19	47.60	49.68	0.640	0.651	41.50	42..90	5.56	5.52	0.98	1.12	100.20	108.80
AV-20	44.30	45.70	0.562	0.572	41.06	42.98	5.80	5.92	1.02	1.12	118.80	116.80
AV-21	41.90	42.06	0.456	0.490	35.40	35.68	5.50	5.40	1.08	1.04	97.00	100.00
AV-22	40.00	42.06	0.426	0.444	33.60	34.46	5.30	5.58	0.88	1.02	98.00	101.80
AV-23	60.00	60.96	0.522	0.532	38.80	39.20	6.44	6.56	1.06	1.10	87.20	87.80
AV-24	42.10	43.32	0.458	0.470	30.40	31.50	4.90	5.20	0.86	0.92	84.60	85.60
AV-25	31.10	32.70	0.304	0.318	27.30	27.14	4.52	4.62	0.76	0.80	61.20	61.60
AV-26	40.00	40.32	0.504	0.534	36.08	35.92	5.28	5.46	0.92	1.00	81.60	81.20
AV-27	38.30	38.98	0.432	0.442	34.56	35.18	5.34	5.42	0.96	1.06	88.00	89.20
AV-28	43.30	44.44	0.484	0.486	38.30	38.34	5.20	5.24	0.96	1.08	86.40	88.20
AV-29	56.20	56.06	0.720	0.720	45.50	45.34	6.86	6.94	1.24	1.34	157.60	158.80
AV-30	54.12	55.72	0.697	0.710	44.60	44.68	6.80	6.86	1.18	1.30	156.00	159.60
CD(%)	5.34	4.73	0.123	0.96	4.54	3.78	0.624	0.608	0.206	0.188	20.124	18.60
SE(+/-)	1.91	1.69	0.044	0.034	1.62	1..35	0.223	0.217	0.073	0.067	7.18	6.64
F Value	26.667**	32.624**	12.161**	19.228**	13.559**	17.739**	11.32**	12.418**	7.38**	9.29**	21.7**	20.626**

Table 2. Continued..

Accession No.	Leaf colour Initial	Leaf colour 1 YAP	Phyllocrone Initial(Days)	Phyllocrone (Final)(Days)	Sucker pdn year^{-1}
AV-1	Green, white spots closer	Green, white spots closer	32.00	34.00	4.60
AV-2	Light green, white spots more towards the base	Green, white spots scattered	40.00	36.80	8.00
AV-3	Green, White spots absent	Green, White spots absent	26.80	28.80	7.40
AV-4	Green, White spots absent	Green, White spots absent	37.80	39.00	7.00
AV-5	Light green, White spots closer and uniformly scattered	Green, white spots scattered	33.60	29.60	7.00
AV-6	Dark green, white spots more towards the base	Green, white spots scattered	25.60	26.80	5.80
AV-7	Green, White spots absent	Green, White spots absent	24.40	26.40	6.60
AV-8	Green, White spots absent	Green, White spots absent	31.60	32.80	5.80
AV-9	Green, White spots absent	Green, White spots absent	27.60	30.80	5.40
AV-10	Green, White spots absent	Green, White spots absent	38.80	34.80	7.00
AV-11	Green, White spots closer and uniformly scattered	Green, white spots scattered	42.00	36.00	7.00
AV-12	Green, white spots more towards the base	Green, white spots scattered	46.00	48.00	6.00
AV-13	Green, White spots closer and uniformly scattered	Green, white spots scattered	46.80	40.80	10.00
AV-14	Dark green, white spots scattered	Green, white spots scattered	42.00	44.00	9.39
AV-15	Green, White spots absent	Green, White spots absent	32.80	30.80	9.20
AV-16	Green, White spots closer and uniformly scattered	Green, white spots scattered	38.00	42.00	11.40
AV-17	Green, Sparse white streaks	Green, Sparse white streaks	33.00	30.00	10.20
AV-18	Green, White spots absent	Green, White spots absent	48.00	44.00	10.00
AV-19	Green, Sparse white streaks	Green, Sparse white streaks	31.60	32.80	10.60
AV-20	Green, White spots closer and uniformly scattered	Green, white spots scattered	27.60	26.40	11.00
AV-21	Green, White spots absent	Green, White spots absent	29.60	27.60	6.00
AV-22	Green, White spots closer and uniformly scattered	Green, White spots absent	38.00	36.00	9.39
AV-23	Green, Sparse white streaks	Green, Sparse white streaks	28.80	30.80	5.80
AV24	Gight green, Sparse white streaks	Green, Sparse white streaks	42.00	40.00	5.60
AV-25	Green, White spots more towards the base	Green, white spots scattered	44.00	48.00	5.40
AV-26	Green, White spots absent	Green, White spots absent	38.00	36.00	6.40
AV-27	Green,White spots closer and uniformly scattered	Green, white spots scattered	36.00	32.80	5.20
AV-28	Green, White spots absent	Green, White spots absent	28.80	30.80	3.40
AV-29	Green, white spots more towards the base	Green, white spots scattered	36.00	34.00	5.20
AV-30	Green, White spots absent	Green, White spots absent	26.40	27.60	5.60
CD (%)	-	-	11.67	9.94	2.57
SE(+/-)	-	-	4.16	3.55	0.919
F value	-	-	2.64**	3.08**	5.43**

* *Significant at 1 % level

on par with AV-6 (48.04 cm), AV-12 (48.02 cm), AV-15 (47.70 cm), AV-13 (47.54 cm) and AV-16 (46.60 cm). The lowest leaf length was recorded by AV-25 (27.30 cm). In final observation also AV-2 (50.26 cm) recorded maximum leaf length which was on par with AV-12 (47.76 cm), AV-16 (47.50 cm), AV-15 (47.30 cm), AV-6 (47.16cm) and AV-13 (46.78 cm) and the lowest leaf length was recorded by AV-25 (27.14 cm).

The data on variation of leaf breadth were presented in Table 2. In the initial observation AV-2 (7.18 cm) showed maximum breadth followed by AV-6 (7.06 cm) and AV-12 (7.06 cm) and were on par with AV-29 (6.86 cm), AV-30 (6.80 cm), AV-16 (6.76 cm), AV-9 (6.66cm) and AV-13 (6.56 cm). In the final observation AV-12 (7.14 cm) and AV-6 (7.14 cm) recorded maximum breadth and were on par with AV-2 (7.12 cm), AV-29 (6.94 cm), AV-16 (6.88 cm), AV-30 (6.86 cm), AV-13 (6.80 cm), AV-9 (6.78 cm), AV-23 (6.56 cm) and AV-14 (6.50 cm).

The thickness of leaves differed significantly among accessions, at two observations. In the initial and final observations significantly highest leaf thickness was recorded by AV-2 and was 1.72 cm and 1.76 cm respectively and the lowest by AV-25, 0.76 cm and 0.80 cm respectively.

The weight of the leaf varied significantly among 30 accessions in both observations. In the initial observation AV-2 recorded the maximum leaf weight (195.00 g) followed by AV-16 (166.00 g) and AV-13 (158.80 g) and in the final observation AV-2 (192.70 g) recorded maximum leaf weight followed by AV-13 (162.00 g) and AV-16 (161.40 g) and were on par with AV-30 (159.60 g), AV-29 (158.80 g) and AV-12 (147.80 g). The leaf weight was lowest for AV- 18 in both the observations and was 59.00 gram and 61.00 gram respectively.

The phyllocrone differed significantly among accessions, at initial and final observations. In the initial observation the lowest phyllocrone was recorded by AV-7 (24.40 days) followed by AV-6 (25.60 days) and the highest number was recorded for AV-18 (48.00 days). In the final observation lowest number of days recorded for AV-7 and AV-20 (26.40 days) and maximum number of days was observed for AV-12 and AV-25 with 48 days.

Plate2. Superior *Aloe vera* accessions based on selection index

Plate 2a Morphologically superior *Aloe vera* accessions

Plate 2a

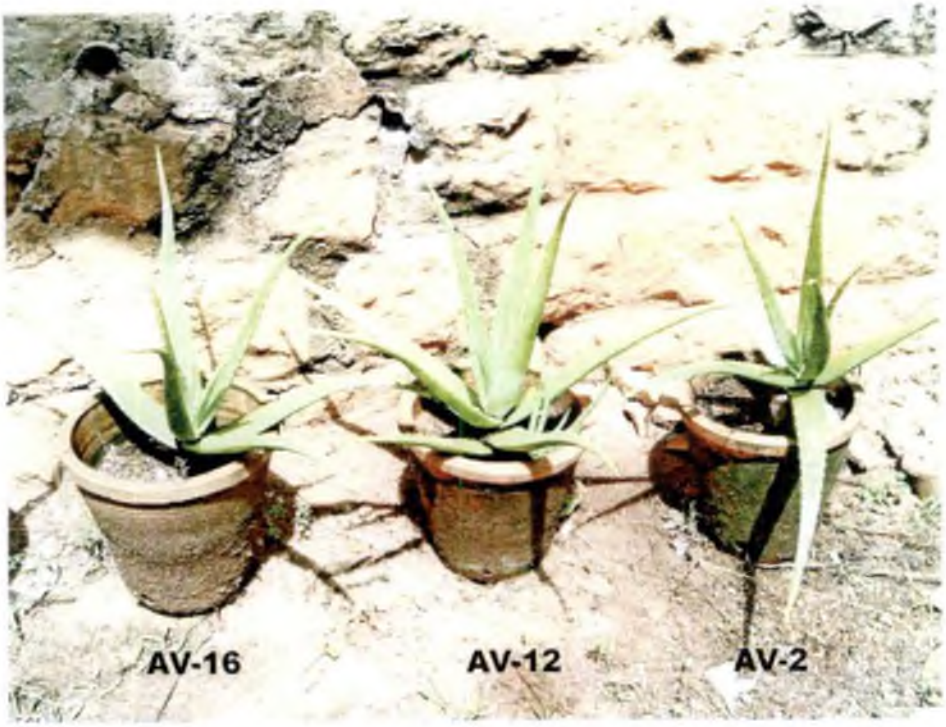


Plate 2b Biochemically superior *Aloe vera* accessions

Plate 2b

AV-5

AV-25

AV-18

AV-23

AV-11

AV-21

Table 3 .Variations in anatomical parameters of *Aloe vera* accessions

Accessions	Number of stomata mm^{-2}	Cuticle thickness (μ m)	Epidermal thickness (μ m)	Mesophyll thickness (cm)
AV1	1.00	6.36	18.00	1.16
AV2	1.00	6.00	15.60	1.22
AV3	1.20	6.00	16.80	1.98
AV4	1.00	6.00	18.00	1.06
AV5	1.00	6.00	18.00	0.94
AV6	1.00	6.24	16.80	1.02
AV7	1.20	6.00	18.00	1.08
AV8	1.00	6.00	18.00	0.94
AV9	1.00	6.12	16.80	0.90
AV10	1.20	6.00	18.00	0.78
AV11	1.00	6.00	18.00	0.78
AV12	1.00	6.00	18.00	0.86
AV13	1.00	6.00	16.80	0.92
AV14	1.00	6.00	16.80	1.04
AV15	1.20	6.24	18.00	0.94
AV16	1.00	6.00	18.00	0.96
AV17	1.20	6.00	16.80	0.86
AV18	1.00	6.12	18.00	0.68
AV19	1.20	6.00	16.80	0.76
AV20	1.00	6.00	18.00	0.82
AV21	1.00	6.12	16.80	0.78
AV22	1.00	6.00	18.00	0.64
AV23	1.00	6.12	16.80	0.74
AV24	100	6.12	16.80	0.62
AV25	1.20	6.00	18.00	0.54
AV26	1.00	6.12	18.00	0.66
AV27	1.00	6.12	18.00	0.66
AV28	1.20	6.00	16.80	0.9
AV29	1.00	6.12	18.00	0.86
AV30	1.20	6.00	18.00	0.86
CD (%)	0.31	0.21	2.10	0.17
SE(+/-)	0.11	0.074	0.77	6.15
F value	0.724	1.57*	0.71	7.11**

** Significant at 1 % level

* Significant at 5 % level

There is no significant variation in leaf shape among various accessions. Leaf colour also showed no significant variation among various accessions. A light green colour was noticed for AV-2 and AV-5. A comparatively dark green coloration was shown by AV-14 during the initial evaluation. Generally younger leaves showed white spots or streaks and it disappeared after attaining maturity, but in certain plants the streaks remained even after attaining maturity and can not be identified as a specific character of an accession. During the final evaluation the colour difference disappeared and all accession appeared green.

The sucker production per year differed significantly among the accessions (Table 2). The highest number of suckers was recorded by AV-16 (11.40) followed by AV-20 (11.00) and was on par with AV-19 (10.60), AV-17 (10.20), AV-13 (10.00), AV-18 (10.00), AV-14 (9.39), AV- 22 (9.39) and AV-15 (9.20) and the lowest sucker production was for AV-28 (3.40).

4.3. ANATOMICAL CHARACTERIZATION

The mean value of the data on anatomical characters of the accessions like number of stomata, cuticle thickness, epidermal thickness and mesophyll thickness were statistically analysed and presented in Table 3

There was no significant variation among the accessions with regard to anatomical characters like number of stomata and epidermal thickness. Majority of accessions recorded one stomata per square millimeter and an epidermal thickness of 18 µm. However, there was significant variation in cuticle and mesophyll thickness among accessions. How ever, AV-1 recorded the maximum cuticle thickness of 6.36 µm, followed by AV-6 (6.24 µm) and AV-15 (6.24 µm) while the cuticle thicknesses of all other accessions were on par with AV-9 (6.12 µm). Mesophyll thickness was the highest for AV-2 (1.22 cm) followed by AV-1 (1.16 cm). The accessions AV-7, AV-4 and AV-14 were next in the order and were on par having 1.08 cm, 1.06 cm and 1.04 cm respectively.

4.4. BIOCHEMICAL CHARACTERIZATION

The data on biochemical characters such as amino acids, total sugars, fatty acids, vitamin A and C, saponins, minerals such as sodium, potassium, calcium,

Table 4.Variation in biochemical parameters of *Aloe vera* accessions during the initial and final evaluation (Mean of 5 replications)

Accessions	Amino acids. g $100g^{-1}$ FW (initial)	Amino acids. g $100g^{-1}$ FW (Final)	Total sugars. g $100g^{-1}$ FW (initial)	Total sugars. g $100g^{-1}$FW (Final)	Free fatty acids mg oleic acid $100g^{-1}$FW (initial)	Free fattyacids mg oleic acid $100g^{-1}$ FW (Final)	Vit. A mg $100g^{-1}$ FW (initial)	Vit. A mg $100g^{-1}$ FW (Final)	Vit. C mg $100g^{-1}$ FW (Initial)	Vit.C mg $100g^{-1}$ FW (Final)	Saponins % FW (Initial)	Saponins % FW (Final)
AV-1	0.294	0.294	3.792	3.808	2.380	2.370	55.920	55.102	19.040	20.944	0.855	0.847
AV-2	0.270	0.286	4.124	4.104	2.504	2.452	54.068	53.034	16.184	17.136	0.902	0.902
AV-3	0.410	0.424	4.338	4.308	3.090	3.126	73.898	74.932	25.708	25.708	0.960	0.960
AV-4	0.466	0.470	3.932	3.894	2.930	3.090	72.880	74.934	26.662	25.708	1.004	1.000
AV-5	0.580	0.594	4.872	4.384	3.592	3.458	125.732	121.798	36.209	34.304	1.220	1.186
AV-6	0.216	0.226	3.734	3.818	2.254	2.332	61.050	59.870	20.994	19.040	0.910	0.918
AV-7	0.264	0.264	3.656	3.728	2.474	2.508	71.762	69.610	22.850	19.992	0.898	0.892
AV-8	0.390	0.402	4.030	4.096	2.930	2.988	87.266	86.266	25.708	27.624	0.964	0.970
AV-9	0.248	0.258	3.786	3.816	2.538	2.572	71.730	69.564	22.848	20.944	0.830	0.830
AV-10	0.326	0.324	3.580	3.636	2.474	2.474	73.800	71.734	20.944	19.992	0.875	0.880
AV-11	0.376	0.372	4.272	4.334	3.122	3.128	94.200	93.166	29.540	30.494	0.968	0.978
AV-12	0.194	0.198	3.792	3.818	2.316	2.410	82.334	82.334	25.708	26.662	0.879	0.897
AV-13	0.278	0.276	3.960	3.654	2.602	2.538	61.032	59.866	31.456	33.361	0.836	0.888
AV-14	0.170	0.182	3.646	3.648	2.440	2.476	69.568	65.168	27.624	28.578	0.908	0.914
AV-15	0.230	0.238	3.756	3.782	2.538	2.574	71.732	71.732	25.708	23.802	0.848	0.866
AV-16	0.268	0.270	3.836	3.856	2.568	2.602	70.634	69.568	31.456	24.756	0.862	0.882
AV-17	0.162	0.172	3.568	3.586	2.286	2.362	73.736	70.636	20.944	19.992	0.912	0.901
AV-18	0.592	0.572	5.664	4.884	3.694	3.498	114.146	111.346	31.456	33.360	1.208	1.158
AV-19	0.416	0.420	4.352	4.184	3.084	3.122	94.526	92.428	25.680	28.356	1.002	1.000
AV-20	0.480	0.486	3.942	3.872	3.000	3.064	77.034	76.066	29.540	31.456	0.970	0.968
AV-21	0.360	0.368	4.268	3.962	3.090	3.090	92.496	92.496	30.534	31.536	0.976	0.978
AV-22	0.436	0.452	4.180	3.950	2.872	3.052	83.132	82.066	30.494	28.578	0.992	0.976
AV-23	0.378	0.386	3.884	3.804	2.994	3.058	95.934	93.866	25.708	27.624	0.976	0.974
AV-24	0.516	0.530	3.930	3.872	2.930	3.052	95.466	93.397	25.708	27.624	1.012	0.994
AV-25	0.644	0.644	5.308	4.822	3.592	3.498	123.802	115.670	31.456	29.540	1.218	1.198
AV-26	0.428	0.446	4.360	4.332	2.930	2.988	91.432	91.432	23.802	27.624	0.974	0.968
AV-27	0.380	0.398	4.266	4.232	3.090	3.090	89.778	89.158	26.662	27.616	0.982	0.970
AV-28	0.432	0.444	3.948	3.892	2.988	3.090	88.112	86.464	29.540	30.494	0.970	0.968
AV-29	0.252	0.258	3.546	3.564	2.538	2.558	56.960	57.784	20.944	19.992	0.834	0.867
AV-30	0.204	0.218	3.732	3.728	2.316	2.508	56.862	58.776	25.708	23.802	0.846	0.877
CD (%)	0.026	0.025	0.211	0.052	0.161	0.125	5.513	4.615	3.752	4.354	0.029	0.032
SE(+/-)	0.009	0.008	0.075	0.018	0.057	0.044	1.968	1.648	1.340	1.555	0.010	0.011
F value	184.96**	202.78**	42.07**	311.44**	48.18**	66.55**	90.54**	115.46**	11.062	9.35**	102.1702**	60.615**

Table 4. Continued...

Accession	Sodium g 100g^{-1} (Initial)	Sodium g 100^{-1} (Final)	Potassium g 100g^{-1} (Initial)	Potassium g 100g^{-1} (Final)	Calcium % (Initial)	Calcium % (Final)	Magnesium % (Initial)	Magnesium % (Final)	Iron mg 100g^{-1} (Initial)	Iron mg 100g^{-1} (Final)	PO g minute^{-1} (Initial)	PO g minute^{-1}(Final)	PPO g minute^{-1} (Initial)	PPO g minute^{-1} (Final)
AV-1	0.037	0.038	0.061	0.068	0.021	0.021	0.022	0.022	0.122	0.138	0.217	0.243	0.129	0.138
AV-2	0.028	0.027	0.064	0.067	0025	0.024	0.023	0.023	0.124	0.134	0.286	0.312	0.138	0.147
AV-3	0.052	0.053	0.091	0.092	0.029	0.029	0.026	0.027	0.226	0.242	0.418	0.417	0.261	0.245
AV-4	0.064	0.064	0.102	0.103	0.036	0.035	0.027	0.027	0.220	0.234	0.487	0.478	0.245	0.277
AV-5	0.118	0.114	0.146	0.146	0.045	0.042	0.030	0.030	0.430	0.424	0.673	0.617	0.390	0.338
AV-6	0.016	0.017	0.075	0.078	0.019	0.021	0.023	0.023	0.156	0.176	0.312	0.321	0.147	0.147
AV-7	0.019	0.018	0.063	0.066	0.023	0.024	0.023	0.023	0.168	0.182	0.218	0.245	0.104	0.129
AV-8	0.059	0.057	0.106	0.109	0.030	0.031	0.026	0.027	0.340	0.342	0.443	0.426	0.261	0.254
AV-9	0.035	0.036	0.064	0.070	0.025	0.054	0.022	0.022	0.148	0.166	0.286	0.295	0.121	0.138
AV-10	0.038	0.037	0.082	0.080	0.023	0.025	0.023	0.023	0.160	0.178	0.208	0.260	0.138	0.156
AV-11	0.067	0.063	0.096	0.096	0.030	0.029	0.027	0.028	0.288	0.306	0.478	0.435	0.286	0.261
AV-12	0.021	0.024	0.059	0.067	0.017	0.018	0.023	0.022	0.130	0.140	0.277	0.304	0.112	0.147
AV-13	0.033	0.032	0.069	0.070	0.025	0.025	0.023	0.023	0.126	0.170	0.252	0.278	0.147	0.129
AV-14	0.038	0.040	0.079	0.081	0.023	0.022	0.022	0.023	0.136	0.174	0.278	0.286	0.103	0.104
AV-15	0.039	0.038	0.064	0.071	0.019	0.023	0.023	0.023	0.178	0.186	0.243	0.286	0.138	0.147
AV-16	0.017	0.020	0.058	0.060	0.018	0.017	0.023	0.023	0.122	0.150	0.208	0.269	0.129	0.164
AV-17	0.024	0.024	0.076	0.080	0.021	0.022	0.023	0.023	0.148	0.178	0.312	0.321	0.104	0.147
AV-18	0.116	0.114	0.205	0.162	0.046	0.040	0.031	0.030	0.448	0.426	0.617	0.530	0.416	0.356
AV-19	0.053	0.046	0.130	0.137	0.036	0.033	0.026	0.027	0.240	0.274	0.443	0.435	0.286	0.211
AV-20	0.048	0.047	0.095	0.042	0.032	0.037	0.027	0.028	0.342	0.332	0.426	0.435	0.211	0.211
AV-21	0.056	0.034	0.130	0.130	0.034	0.036	0.027	0.028	0.288	0.296	0.452	0.427	0.253	0.227
AV-22	0.058	0.054	0.114	0.113	0.036	0.036	0.028	0.028	0.342	0.332	0.452	0.444	0.278	0.236
AV-23	0.065	0.064	0.127	0.122	0.035	0.034	0.027	0.028	0.372	0.364	0.495	0.470	0.211	0.229
AV24	0.048	0.052	0.109	0.281	0.314	0.030	0.027	0.027	0.362	0.356	0.418	0.461	0.286	0.286
AV-25	0.127	0.116	0.149	0.139	0.060	0.050	0.033	0.032	0.464	0.434	0.686	0.591	0.408	0.365
AV-26	0.055	0.024	0.094	0.097	0.034	0.036	0.026	0.028	0.336	0.328	0.434	0.426	0.286	0.286
AV-27	0.618	0.058	0.128	0.124	0.029	0.028	0.028	0.027	0.370	0.368	0.444	0.461	0.245	0.254
AV-28	0.055	0.055	0.123	0.121	0.035	0.034	0.027	0.027	0.358	0.344	0.418	0.444	0.228	0.211
AV-29	0.016	0.020	0.064	0.067	0.021	0.024	0.023	0.023	0.162	0.178	0.225	0.278	0.156	0.164
AV-30	0.044	0.023	0.776	0.078	0.024	0.025	0.023	0.025	0.166	0.186	0.304	0.329	0.112	0.156
CD (%)	0.0104	0.0034	0.0052	0.0051	0.0034	0.0252	0.0016	0.0015	0.016	0.0152	0.0643	0.0492	0.0482	15.285
SE (+/)	0.0037	0.0012	0.0018	0.0016	1.223	0.009	0.0006	0.0006	0.0057	0.0054	0.0229	0.0175	0.0172	0.0184
F value	57.888**	479.72**	340.791**	1.901**	61.347**	1.501	24.096**	25.123**	380.74**	323.934**	34.478**	34.397**	29.365**	0.0517**

FW - Fresh weight

** Significant at 1 % level

* Significant at 5 % level

magnesium and iron and enzymes like peroxidase and polyphenol oxidase of the thirty accessions were analysed statistically and presented in Table 4

4.4.1. Amino acids

The amino acid content varied significantly among the accessions in the initial and final observations.

In the initial evaluation, maximum amino acid content was recorded by AV-25 (0.644g 100 g $^{-1}$ FW), followed by AV-18 (0.592 g) and the lowest by AV-17 (0.162 g). In the final evaluation also AV-25 recorded highest amino acid content of 0.644 g, followed by AV-5 (0.594 g) and the lowest by AV-17 (0.172 g).

4.4.2. Total sugars

The total sugar content differed significantly among accessions, in the initial and final evaluation.

In the initial evaluation AV-18 recorded maximum total sugar content of 5.664 g 100 g $^{-1}$ FW, followed by AV-25 (5.308 g) and AV-29 (3.546 g) recorded the lowest sugar content. In the final phytochemical analysis also AV-18 recorded highest total sugar content of 4.884 g, followed by AV-25 (4.822 g) and AV-29 (3.56 g) with the lowest sugar content.

4.4.3. Total free fatty acids

The total free fatty acid content of the accessions differed significantly. In the initial observation the total free fatty acid content recorded was the highest in AV-18 (3.694 mg of oleic acid 100 g $^{-1}$ FW) followed by AV-25 (3.592 mg) and AV-5 (3.592 mg) and the lowest free fatty acid content was observed in AV-6 (2.254 mg). In the final observation the total free fatty acid content recorded was the highest in AV-18 and AV-25 with 3.498 mg followed by AV-5 (3.458 mg) and the lowest fatty acid content was observed in AV-6 with 2.332 mg.

4.4.4. Vitamin A

The data on the amount of vitamin A present in the accessions were statistically analysed and presented in Table 4.

In the initial observation the vitamin A content was the highest in AV-5 (125.732 mg per 100 g FW) and was on par with that of AV-25 (123.802 mg),

followed by AV-18 (114.146 mg) and the lowest value was in AV-2 (54.068 mg). In the final observation also the same trend was noticed with the highest content in AV-5 (121.798 mg), followed by AV-25 (115.670 mg) and the lowest in AV-2 (53.034 mg).

4.4.5. Vitamin C

The data on the amount of vitamin C present in the accessions were statistically analysed and presented in Table 4.

In the initial phytochemical analysis the highest Vitamin C content was recorded in AV-5 (36.209 mg 100 g^{-1} FW) followed by AV-18 (31.456 mg) and the lowest was in AV-2 (16.184 mg). In the final analysis also AV-5 recorded maximum vitamin C content of 34.304 mg, which was on par with AV-13 and AV-18 with 33.361 mg and 33.360 mg respectively and the lowest vitamin C content was recorded by AV-2 with 17.136 mg.

4.4.6. Saponins

The data on the amount of saponin present in the thirty accessions were statistically analysed.

In the initial phytochemical analysis it was observed that the Saponin content was the highest in AV-5 (1.22 %), which was on par with AV-25 (1.218 %) and AV-18 (1.208 %). The lowest amount of saponin was observed in AV-9 (0.830 %) followed by AV-29 (0.834 %). In the final phytochemical analysis also AV-25 (1.198 %) recorded highest saponin content which was on par with AV-5 (1.186 %), followed by AV-18 (1.158 %). The lowest saponin content was observed in AV-9 (0.830 %) and was on par with AV-1 (0.847 %).

4.4.5. Sodium

The data on the amount of sodium in the accessions were statistically analysed.

In the initial phytochemical analysis sodium content was the highest in AV-25 (0.127 g 100 g^{-1} FW) and was on par with AV-5 (0.118 g). The lowest content of sodium was recorded in AV-6 (0.016 g). In the final analysis the sodium content was highest in AV-25 (0.116 g) and was on par with AV-18

(0.114 g) and AV-5 (0.114 g). The lowest sodium content was recorded in AV-6 (0.017 g).

4.4.6. Potassium

The data on the amount of potassium in the accessions were statistically analysed.

In the initial phytochemical analysis it was observed that the potassium content was the highest in AV-18 with 0.205 gm 100 g^{-1} FW, followed by AV-25 with 0.149 g. The lowest content of potassium was observed in AV-16 (0.058 g). In the final observation AV-24 (0.281 g)) recorded the highest potassium content followed by AV-18 (0.162 g), AV-5 (0.146 g) and AV-25 (0.139 g) respectively. The lowest amount of potassium was observed in AV-16 (0.060 g).

4.4.7. Calcium

The data on the amount of calcium in thirty accessions were statistically analysed and presented in Table 4

In the initial phytochemical analysis it was observed that the calcium content was highest in AV-25 (0.060 %), followed by AV-18 (0.046 %). The lowest content of calcium was observed in AV-12 (0.017 %), followed by AV-16 (0.018 %). In the final observation calcium content was the highest in AV-9 (0.054 %) and was on par with AV-25 (0.050 %). The lowest calcium content was observed in AV-16 (0.017 %), followed by AV-12 (0.018 %)

4.4.8. Magnesium

The data on the amount of magnesium content in accessions were statistically analysed and presented in Table 4.

In the initial phytochemical analysis it was observed that magnesium content was highest in AV-25 (0.033 %) and was on par with AV-18 (0.031 %) followed by AV-5 (0.030 %). The lowest magnesium content was observed in AV-1 (0.021 %) followed by AV-14 and AV-9 with 0.022 %. In the final phytochemical analysis it was observed that magnesium content was the highest in AV-25 (0.032 %) followed by AV 18 (0.030 %) and the lowest amount of magnesium was observed in AV-12, AV-1, AV-6 and AV-9 with 0.022 %.

4.4.9. Iron

The data on the amount of iron content in the accessions were statistically analysed and presented in Table 4.

In the initial phytochemical analysis it was observed that iron content was highest in AV-25 (0.464 %) and was on par with AV-18 (0.448 %), followed by AV-5 (0.430 %). The lowest iron content was observed in AV-1 and AV-16 with 0.122 %. In the final analysis also iron content was highest in AV-25 (0.434 %) and was on par with that of AV-18 (0.426 %) and AV-5 (0.424 %). The lowest iron content was observed in AV-2 (0.134 %) followed by AV-1(0.138 %), AV-12 (0.140 %) and AV-16 (0.150 %).

4.4.10 Enzymes

a. Peroxidase (PO)

The data on the peroxidase activity in the accessions were statistically analysed and presented in Table 4.

In the initial phytochemical analysis it was observed that the PO activity was highest in AV-25 (0.686 g minute^{-1}) and was on par with AV-5 (0.673 g minute^{-1}). The lowest enzyme activity was shown by AV-10 and AV-16 with 0.208 g minute^{-1}. In final phytochemical analysis the maximum enzyme activity was shown by AV-5 (0.617 g minute^{-1}) and was on par with that of AV-25 (0.591 g minute^{-1}) and the lowest enzyme activity was shown by AV-1 (0.243 g minute^{1}).

b. Polyphenol oxidase (PPO)

The data on the polyphenol oxidase activity in thirty accessions were statistically analysed and presented in Table 4.

In the initial phytochemical analysis it was observed that the PPO activity was highest in AV-18 (0.416 g minute^{-1}) and was on par with AV-25 (0.408 g minute^{-1}) and AV-5 (0.390 g minute^{-1}). The lowest activity was shown by AV-17, AV-7 and AV-14 with 0.104 g minute^{-1}. In the final phytochemical analysis the highest activity was shown by AV-25 (0.365 g minute^{-1}) and was on par with AV-

Fig. 1. Leaf yield and latex yield of various accessions of *Aloe vera*

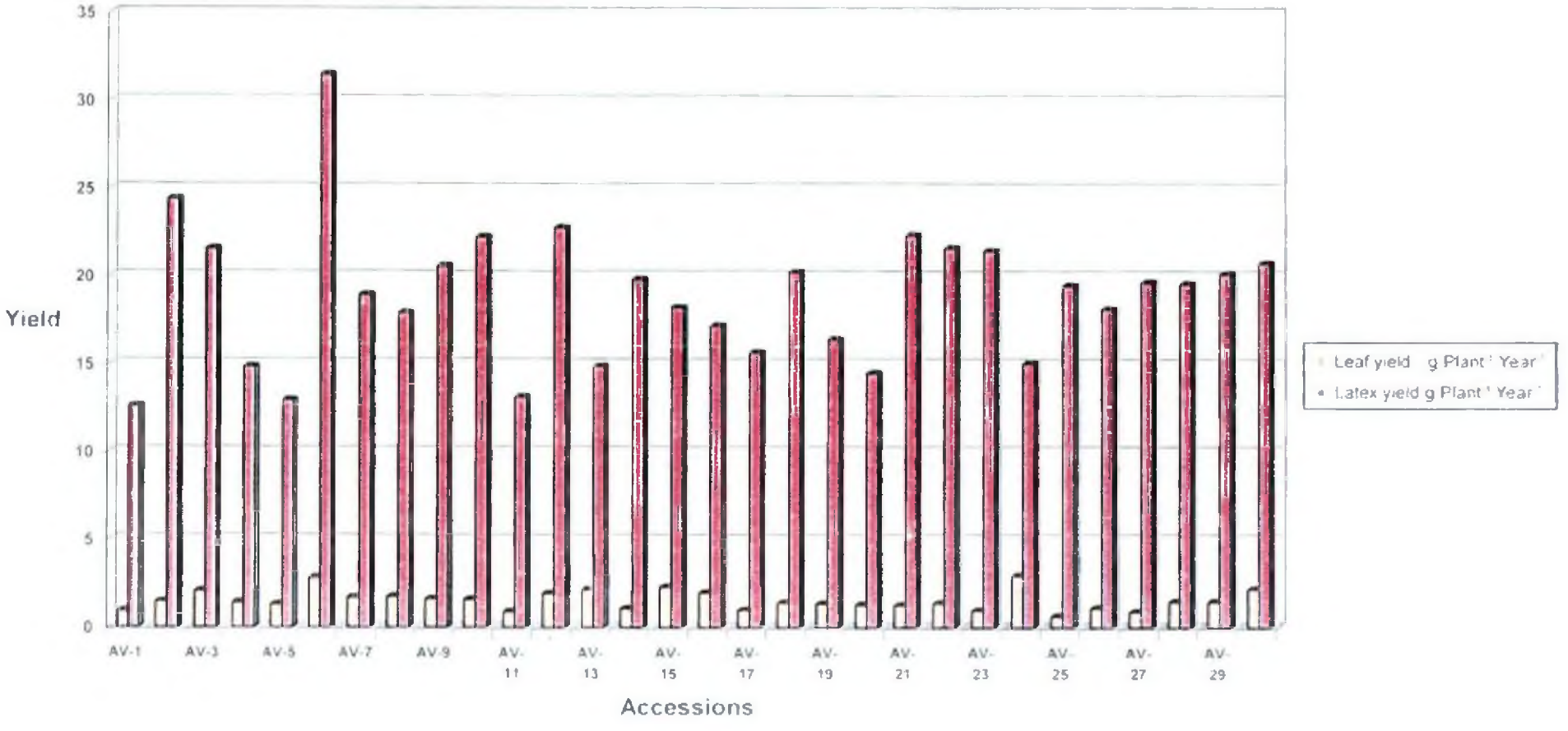


Table 5. Leaf and latex yield of *Aloe vera* accessions

Accession	Leaf yield kg plant^{-1} year^{-1}	Latex yield grams plant^{-1} year^{-1}
AV-1	0.904	12.568
AV-2	1.440	24.366
AV-3	2.042	21.542
AV-4	1.380	14.820
AV-5	1.290	12.924
AV-6	2.792	31.464
AV-7	1.680	18.936
AV-8	1.716	17.894
AV-9	1.582	20.566
AV-10	1.576	22.212
AV-11	0.856	13.106
AV-12	1.926	22.754
AV-13	2.122	14.842
AV-14	1.044	19.808
AV-15	2.270	18.198
AV-16	1.952	17.156
AV-17	0.950	15.628
AV-18	1.358	20.216
AV-19	1.333	16.384
AV-20	1.271	14.462
AV-21	1.253	22.326
AV-22	1.326	21.594
AV-23	0.943	21.430
AV-24	2.922	15.024
AV-25	0.599	19.444
AV-26	1.078	18.116
AV-27	0.865	19.644
AV-28	1.451	19.546
AV-29	1.456	20.106
AV-30	2.162	20.716
CD (%)	0.208	3.009
SE (+/-)	0.074	1.074
F Value	56.757**	13.635**

** Significant at 1 % level

Plate 3 (3a and 3b) Harvested leaves of *Aloe vera*

Plate 4 Cross section of *Aloe vera* leaf

Plate 3a

Plate 3b

Plate 4

Plate 5 Variations in leaf characters in *Aloe vera* accessions

Plate 5


AV-15
AV-16
AV-12
AV-2

Plate 6 ***Aloe vera*** **gel**

Plate 7 ***Aloe vera*** **latex oozing out from a leaf**

Plate 6

Plate 7

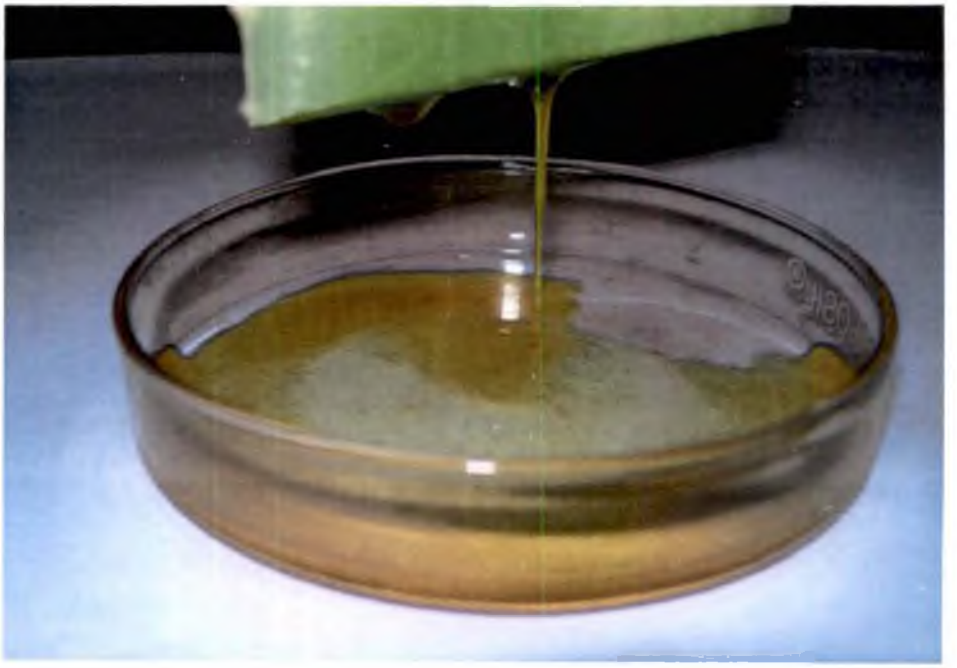


Plate 8a and 8b Fresh latex

Plate 9 Dried latex of *Aloe vera*

Plate 8a

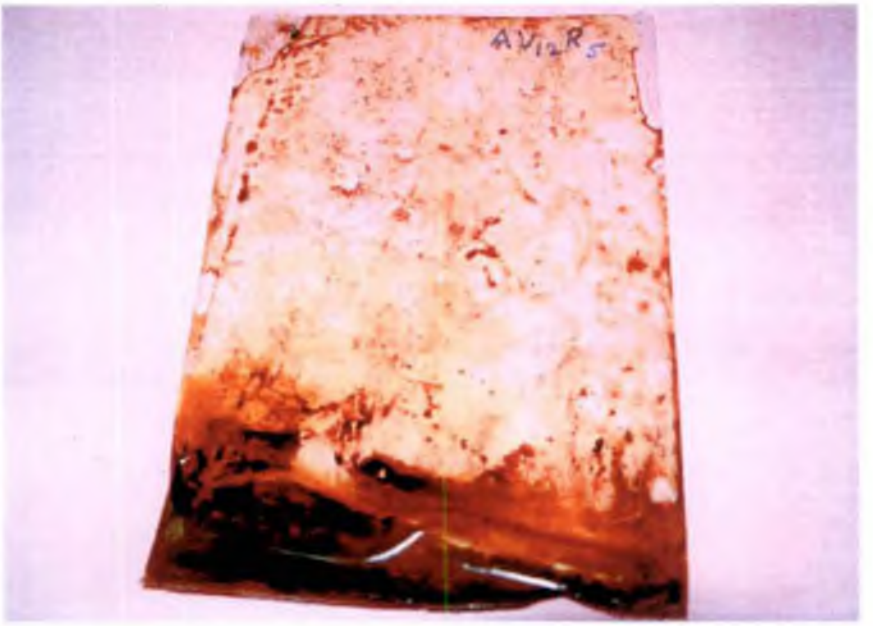


Plate 8b

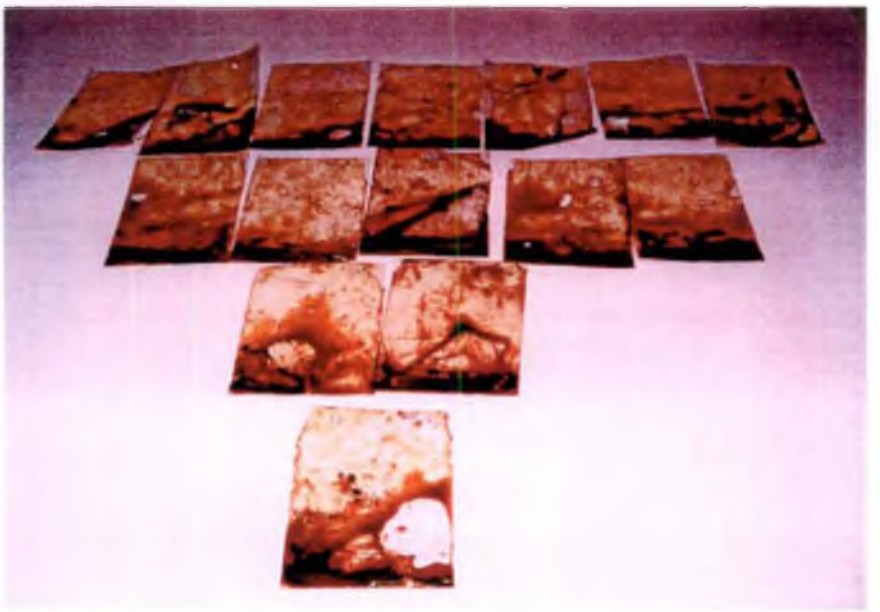


Plate 9

Table 6
Calculated t – value of morphological and biochemical parameters in *Aloe vera* accessions

Sl.No.	Character	t-value
1	Plant height	3.704**
2	Plant spread	4.431**
3	Leaf length	3.270**
4	Leaf breadth	3.517**
5	Leaf thickness	3.784**
6	Leaf weight	2.053*
7	Phyllocrone	0.986
8	Amino acid	4.899**
9	Total sugars	4.477**
10	Fatty acids	2.867**
11	Vitamin A	3.967**
12	Vitamin C	0.006
13	Saponins	0.241 --
14	Sodium	2.373*
15	Potassium	0.899
16	Calcium	2.745**
17	Magnesium	2.785**
18	Iron	5.310**
19	Peroxidase	0.758
20	Polyphenol oxidase	0.619

** Significant at 1% level
* Significant at 2% level

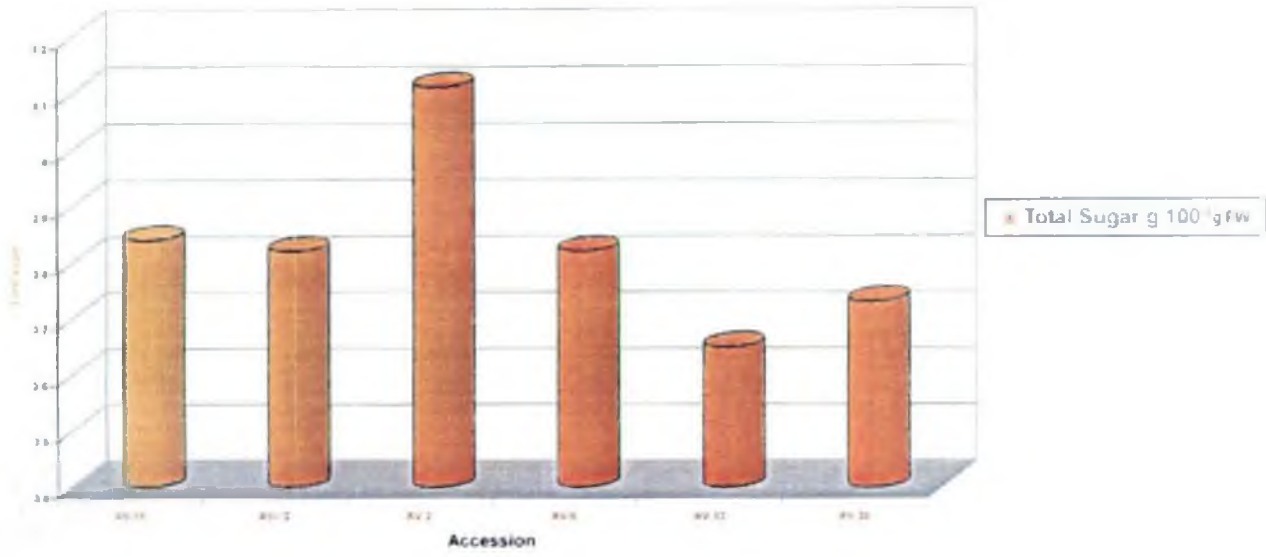
Table 7.1 Phenotypic correlation coefficients of morphological and biochemical characters in *Aloe vera*

Character	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII
I	1.0000																						
II	0.7816	1.0000																					
III	0.7718	0.8256	1.0000																				
IV	0.7688	0.6782	0.7317	1.0000																			
V	0.5074	0.5928	0.4950	0.4438	1.0000																		
VI	0.6594	0.7115	0.7768	0.7564	0.4630	1.0000																	
VII	-0.0149	-0.0478	-0.0477	0.0017	-0.1086	0.0005	-1.0000																
VIII	-0.6591	-0.6298	-0.7269	-0.6867	-0.4339	-0.7176	0.1081	1.0000															
IX	-0.5282	-0.4656	-0.5615	-0.5873	-0.3295	-0.6277	0.1920	0.7419	1.0000														
X	-0.6435	-0.6616	-0.7117	-0.6791	-0.4280	-0.7137	0.0724	0.8947	0.7575	1.0000													
XI	-0.5836	-0.6658	-0.6686	-0.6012	-0.5593	-0.7221	0.1148	0.7879	0.7296	0.8410	1.0000												
XII	-0.4484	-0.4645	-0.3683	-0.3831	-0.4560	-0.3702	0.1213	0.5234	0.4200	0.5963	0.5826	1.0000											
XIII	-0.5608	-0.6147	-0.6393	-0.5969	-0.4310	-0.6995	0.1750	0.8414	0.7902	0.8399	0.8477	0.5207	1.0000										
XIV	-0.6596	-0.6641	-0.6928	-0.6677	-0.4347	-0.7547	0.1700	0.8576	0.8121	0.8589	0.8549	0.5671	0.9016	1.0000									
XV	-0.2603	-0.2790	-0.3863	-0.3464	-0.3211	-0.3505	0.0669	0.4019	0.2420	0.3753	0.3671	0.2510	0.3301	0.3210	1.0000								
XVI	-0.1835	-0.1454	-0.2198	-0.1159	-0.0820	-0.1892	-0.0683	0.2542	0.2198	0.2812	0.2460	0.1624	0.1977	0.2711	0.0496	1.0000							
XVII	-0.6131	-0.6014	-0.6596	-0.6226	-0.4568	-0.6870	0.0690	0.8405	0.7392	0.8714	0.7875	0.5598	0.7870	0.8062	0.3590	0.2148	1.0000						
XVIII	-0.6617	-0.6847	-0.7098	-0.6531	-0.5559	-0.7550	0.0233	0.8724	0.6991	0.8950	0.8709	0.5926	0.8255	0.8469	0.3991	0.2588	0.8751	1.0000					
XIX	-0.5465	-0.6169	-0.6763	-0.5903	-0.4247	-0.6931	0.0654	0.8364	0.7078	0.8659	0.8204	0.5108	0.8490	0.8436	0.3788	0.2481	0.8324	0.8784	1.0000				
XX	-0.5511	-0.5806	-0.6809	-0.5888	-0.3823	-0.6552	0.1140	0.8217	0.7454	0.8081	0.7564	0.4922	0.7858	0.7911	0.3695	0.1558	0.7782	0.7853	0.7876	1.0000			
XXI	0.4666	0.4150	0.3168	0.3138	0.2170	0.3921	-0.0890	-0.2449	-0.3218	-0.3129	-0.3126	-0.1934	-0.2881	-0.4047	0.0211	-0.1466	-0.3228	-0.3157	-0.2824	-0.2358	1.0000		
XXII	0.4734	0.3283	0.2418	0.3156	0.1505	0.1889	-0.0402	-0.2612	-0.0645	-0.2381	-0.2093	-0.3240	-0.1542	-0.2332	-0.1320	-0.1019	-0.1756	-0.1852	-0.1847	-0.1425	0.2645	1.0000	
XXIII	0.1165	0.1641	0.1886	0.0612	0.0361 0	0.1667	0.1353	-0.0524	-0.0020	-0.0287	-0.0501	0.1737	0.0076	-0.0446	-0.0811	-0.1163	-0.0084	0.0992	-0.0635	-0.0489	0.0068	-0.1873	1.0000

Table 7. 2 Genotypic Correlation coefficients of morphological and biochemical characters in *Aloe vera*

Character	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII
I	1.0000																						
II	0.8794	1.0000																					
III	0.8635	0.9110	1.0000																				
IV	0.9128	0.8053	0.8736	1.0000																			
V	0.6362	0.8370	0.6835	0.5678	1.0000																		
VI	0.7822	0.8163	0.8877	0.8870	0.5479	1.0000																	
VII	-0.0698	-0.1821	-0.1456	-0.1352	-0.4135	-0.1185	1.0000																
VIII	-0.7162	-0.7162	-0.8371	-0.8236	-0.5709	-0.8202	0.1868	1.0000															
IX	-0.5702	-0.5239	-0.6422	-0.6980	-0.4304	-0.7147	0.3514	0.7562	1.0000														
X	-0.7052	-0.7504	-0.8275	-0.8255	-0.5977	-0.8290	0.1233	0.9366	0.7942	1.0000													
XI	-0.6249	-0.7597	-0.7691	-0.7295	-0.7096	-0.8229	0.2597	0.8079	0.7522	0.8833	1.0000												
XII	-0.5950	-0.6855	-0.5355	-0.5870	-0.6399	-0.5630	0.3190	0.6641	0.5172	0.8008	0.7484	1.0000											
XIII	-0.6254	-0.6988	-0.7476	-0.7316	-0.5733	-0.8017	0.3075	0.8809	0.8300	0.8909	0.8977	0.7127	1.0000										
XIV	-0.7149	-0.7536	-0.7900	-0.7910	-0.5500	-0.8530	0.3256	0.8710	0.8225	0.8950	0.8774	0.7136	0.9415	1.0000									
XV	-0.7572	-0.8586	-0.9719	-0.8920	-0.8815	-0.9320	0.2813	1.0210	0.5993	0.9519	0.9735	0.7308	0.9224	0.8303	1.0000								
XVI	-0.7486	-0.6657	-0.8518	-0.6317	-0.5823	-0.7462	-0.0113	0.8672	0.7201	0.8654	0.7837	0.4500	0.6874	0.9077	0.7519	1.0000							
XVII	-0.7186	-0.7766	-0.8651	-0.8354	-0.6520	-0.8629	0.0916	0.9435	0.8191	0.9922	0.8863	0.7426	0.9271	0.8889	0.9588	0.8159	1.0000						
XVIII	-0.7136	-0.7827	-0.8132	-0.7800	-0.7070	-0.8620	0.0569	0.8889	0.7101	0.9340	0.8918	0.7577	0.8686	0.8577	1.0451	0.7756	0.9678	1.0000					
XIX	-0.6365	-0.7410	-0.8062	-0.7519	-0.5669	-0.8463	0.1102	0.9152	0.7660	0.9639	0.8948	0.7476	0.9455	0.9041	0.9971	0.8455	0.9911	0.9420	1.0000				
XX	-0.7155	-0.7687	-0.8850	-0.8540	-0.6216	-0.8822	0.2667	0.9603	0.8624	0.9695	0.9062	0.6543	0.9422	0.9281	1.0100	0.8493	0.9975	0.9346	0.9822	1.0000			
XXI	0.5351	0.4963	0.3945	0.3798	0.2614	0.4546	-0.1253	-0.2553	-0.3373	-0.3490	-0.3361	-0.2233	-0.3289	-0.4281	0.1837	-0.4658	-0.3636	-0.3364	-0.3308	-0.2908	1.0000		
XXII	0.5477	0.4377	0.2932	0.4607	0.1582	0.2051	-0.1240	-0.3023	-0.0716	-0.2913	-0.2348	-0.4180	-0.1806	-0.2809	-0.2910	-0.0664	-0.2144	-0.2138	-0.2039	-0.2724	0.3130	1.0000	
XXIII	0.1421	0.1956	0.3082	0.0947	0.0055	0.2624	0.1742	-0.0808	-0.0014	0.0238	-0.0768	0.1876	0.0229	0.0672	-0.2014	-0.3011	-0.0950	0.1369	-0.1124	-0.1472	0.0149	-0.2386	1.0000

Fig.2a Total sugar content in six superior accessions selected based on morphological characters



2b. Total sugar content in six superior accession based on biochemical characters

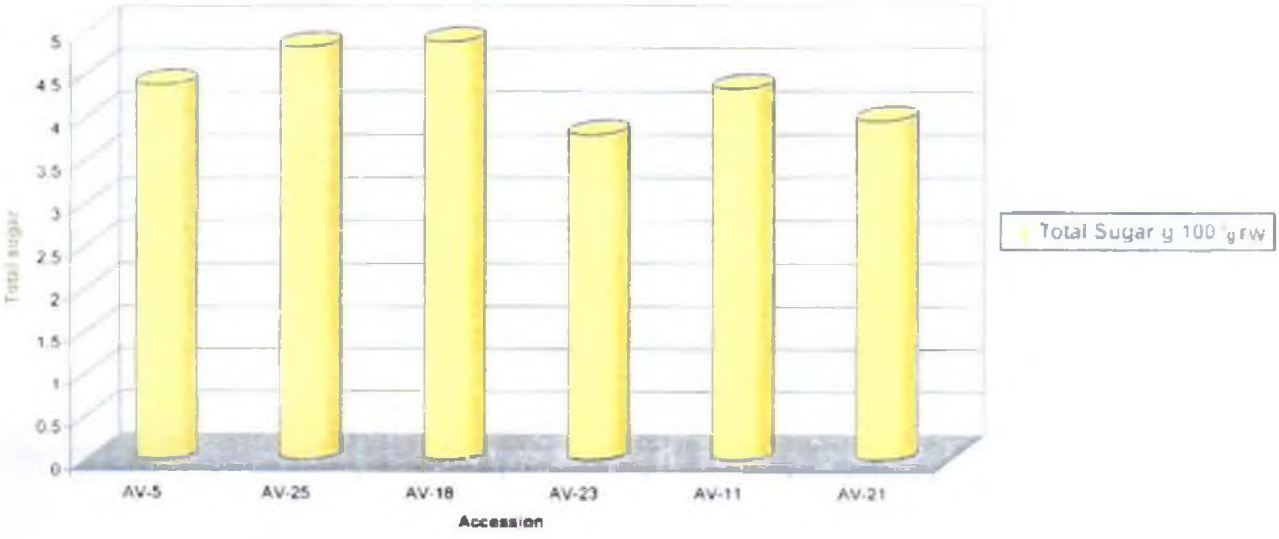
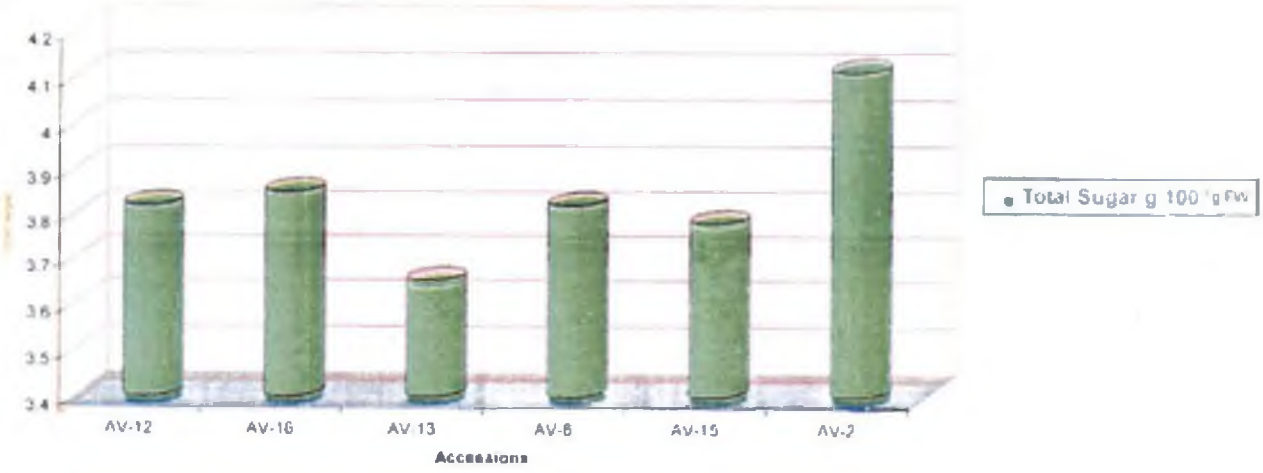


Fig. 2c Variation in total sugar content in six superior accessions based on morpological and biochemical characters



18 (0.356 g minute^{-1}) and AV-5 (0.338 g minute^{-1}). The lowest activity was shown by AV-14 (0.104 g minute^{-1}).

4.5 YIELD

The data on leaf yield and latex yield were statistically analysed and presented in Table 5. Plate 3

4.5.1 Leaf Yield

The highest leaf yield was obtained from AV-24 (2.922 kg plant^{-1} year^{-1}) and was on par with AV-6 (2.792 kg) the lowest yield was obtained from AV-25 (0.599 kg). (Plate 4, Plate 5 and Plate 6 and Fig 1)

4.5.2 Latex Yield

The highest latex yield was obtained from AV-6 (31.464 g plant^{-1} year^{-1}) and was on par with AV-2 (24.366 g), AV-12 (22.754 g) and AV-21 (22.326 g). The latex yield was lowest from AV-1 (12.568 g). (Plate 7, Plate 8 and plate 9)

4.6 PAIRED t- TEST

Paired t test was conducted to find out whether there were any significant changes in the morphological, biochemical and yield contributing characters of the accessions one year after planting. Analysis of the data revealed that significant difference in the initial and final observations in some of the yield contributing characters like plant height (t-value, 3.704), plant spread (t-value, 4.431), leaf length (t-value, 3.270), leaf breadth (t-value, 3.517), leaf thickness (t-value, 3.784) and some of the qualitative parameters like amino acid (t-value, 4.899), total sugars (t-value, 4.477), fatty acids (t-value, 2.867), vitamin A (t-value, 3.967), sodium (t-value, 2.373), magnesium (t-value, 2.785) and iron (t-value, 5.310). The t values are presented in Table 6.

4.7 CORRELATION STUDIES

The phenotypic, genotypic and environmental correlation among the characters were worked out and presented in Table 7.

4.7.1 Phenotypic Correlation Coefficient

The plant height was positively and significantly correlated with plant spread (0.7816), leaf length (0.7718), leaf breadth (0.7688), leaf thickness

(0.5074), leaf weight (0.6594), leaf yield (0.4666) and latex yield (0.4734). Also a positive association is noted with sucker production per year (0.1165). However a strong negative association was found with biochemical characters.

The plant spread was positively and significantly correlated with leaf length (0.8256), leaf breadth (0.6782), leaf thickness (0.5928), leaf weight (0.7115), leaf yield (0.4150) and latex yield (0.4283). However, a strong negative correlation was found with biochemical characters.

The leaf length was positively and highly correlated with leaf breadth (0.7317), leaf thickness (0.4950) and leaf weight (0.7768) and also a positive association was found with leaf yield (0.3168). However, a strong negative correlation was found with biochemical characters.

The leaf breadth was positively and highly correlated with leaf weight (0.7764) and leaf thickness (0.4438). Also a positive association is found with leaf yield (0.3138) and latex yield (0.3156). Strong negative association was obtained with biochemical characters

Leaf thickness was positively and significantly correlated with leaf weight (0.4630). A negative correlation was found with biochemical constituents.

Leaf weight was positively correlated with yield (0.3921). Also a strong negative correlation was found with biochemical constituents.

Biochemical constituents were positively correlated with each other and negatively correlated with morphological characters.

4.7.2 Genotypic Correlation Coefficient

Genotypic correlation coefficients were in general closer to phenotypic correlation coefficients of characters under study. High positive association was obtained for plant height, plant spread, leaf length, leaf breadth, leaf thickness and leaf weight. A strong negative correlation was observed between morphological and biochemical characters.

4.7.3 Error Correlation Coefficient

Most of the error correlation coefficients were very low. However, error correlation between height, spread, and leaf breadth and leaf length were higher

Table 8. Ranking of *Aloe vera* accessions based on selection index (S.I)

Rank	Accession (Morphological character)	S.I	Accession (biochemical character)	S.I	Accession (Morphological and biochemical)	S.I
1	AV-16	1304.78	AV-5	809.70	AV-12	1742.43
2	AV-12	1285.49	AV-25	773.73	AV-16	1700.93
3	AV-2	1270.08	AV-18	765.20	AV-13	1604.67
4	AV-6	1215.58	AV-23	644.41	AV-6	1579.94
5	AV-13	1215.50	AV-11	640.78	AV-15	1564.89
6	AV-30	1200.55	AV-21	638.88	AV-2	1549.93
7	AV-29	1185.21	AV-24	629.17	AV-30	1534.99
8	AV-15	1174.29	AV-27	623.13	AV-19	1492.35
9	AV-9	1071.12	AV-19	622.33	AV-29	1491.01
10	AV-7	1013.83	AV26	614.62	AV-14	1455.62
11	AV-17	999.47	AV-28	610.43	AV-9	1449.18
12	AV-14	991.51	AV-8	603.10	AV-7	1427.16
13	AV-10	989.32	AV-22	584.64	AV-17	1422.24
14	AV-19	973.53	AV-20	560.98	AV-23	1421.21
15	AV-23	961.79	AV-4	542.78	AV-10	1390.90
16	AV-20	989.32	AV-13	540.58	AV-21	1364.59
17	AV-3	881.31	AV-12	536.27	AV-20	1363.83
18	AV-8	876.65	AV-15	499.76	AV-3	1353.90
19	AV-4	852.79	AV-14	487.38	AV-18	1331.50
20	AV-22	841.76	AV-17	482.58	AV-24	1327.61
21	AV-24	831.15	AV-10	481.72	AV-11	1327.10
22	AV-21	827.22	AV-16	480.64	AV-22	1304.67
23	AV-28	811.50	AV-7	472.72	AV-8	1304.22
24	AV-1	798.47	AV-9	470.96	AV-4	1301.93
25	AV-26	762.00	AV-13	464.33	AV-5	1301.00
26	AV-27	749.78	AV-30	442.08	AV-28	1293.73
27	AV-11	747.54	AV-6	429.49	AV-26	1267.36
28	AV-5	667.01	AV-29	426..08	AV-27	1249.13
29	AV-18	670.61	AV-1	408.15	AV-25	1234.68
30	AV-25	579.66	AV-2	394.58	AV-1	1199.40

S.I- Selection index

compared to other characters. Environmental correlation were found to be negligible among yield contributing characters except for height, spread, leaf length, leaf breadth, leaf thickness and leaf weight.

4.7 SELECTION INDEX

Selection indices were worked out through discriminant function analysis (Smith, 1936) based on the morphological (10 characters) and biochemical characters (13 characters) to identify superior genotypes. The index values for each accession were ranked accurately. The selection indices are presented in Table 8 along with ranking of each genotype (Fig 2.).

As per the results obtained, the accessions were ranked in descending order of genotypic superiority, under the following sections:

a) Morphological characters: AV-16, AV-12, AV-2, AV-6, AV-13, AV-30, AV-29, AV-15, AV-9 and AV-7.

b) Biochemical characters: AV-5, AV-25, AV-18, AV-23, AV-11, AV-21, AV24, AV-27, AV19 and AV-26.

c) Morphological and biochemical characters: AV-12, AV-16, AV-13, AV-6, AV-15, AV-2, AV-30, AV-19, AV-29 and AV-14.

DISCUSSION

5. DISCUSSION

The present study "Collection, characterization and evaluation of *Aloe vera* (L.) Burm.f. germplasm" was carried out at the Department of Plantation crops and Spices, College of Agriculture, Vellayani, during the period 2005 – 2007. The objectives of the study were to collect *Aloe vera* (syn. *Aloe barbadensis*) germplasm from different agroclimatic zones of Kerala and Tamil Nadu and to characterize them based on morphological, anatomical and biochemical variability and to select promising ecotypes.

The genetic improvement of any crop aims at increasing the production potential and quality by altering the genetic make up of the existing population. To achieve this goal, a plant breeder requires information on certain genetic parameters like variability and association between characters. In the present study, the variability existed in thirty aloe accessions collected from different places in Kerala and Tamil Nadu were analysed statistically and association between morphological, biochemical and yield contributing characters were worked out and the accessions were ranked based on selection indices.

The results of the study are discussed in this chapter.

5.1 CHARACTERIZATION OF LAND RACES

5.1.1 **Morphological Characterization**

Analysis of variance showed significant difference among the accessions of aloe for all the morphological characters studied.

The height of the accessions ranged from 31.00 cm to 68.90 cm during the initial evaluation and almost the same range was maintained one year after planting. During the initial and final evaluation AV-2 was the tallest accession followed by AV-6 and AV-12, while AV-25 was the dwarfest accession. This observation is in consonance with the findings of Singh et al. (2005), who reported wide variation in plant height ranging from 36.00 to 62.53 cm in aloe germplasm.

Wide variation in plant spread was also observed for the thirty accessions evaluated. It was the highest for AV-2 and lowest for AV-25 in both observations.

Length of leaf ranged from 27 cm to 51 cm in the thirty accessions. Higher leaf length was observed in accessions AV-2, AV-6, AV-12, AV-15, AV-13 and AV-16 while the lowest leaf length was for AV-25. Wang and Strong (1933) reported that there was considerable variation in the size of leaves collected from different sites. The average leaf length reported in the high yielding variety 'CIM Sheetal' released from CIMAP possessed an average leaf length of 60 cm to 65 cm (Singh et al., 2005).

Breadth of leaf also showed variation among the accession and ranged from 4.52 to 7.18 cm. The accessions having highest leaf breadth were AV-12, AV-6, AV-2, AV-16, AV-30 and AV-13. Lowest leaf breadth was observed in AV-25. In the final evaluation also, same trend was noticed. Earlier reports about morphology of aloe records an average leaf breadth of 10 cm (Farooqi and Sreeramu, 2001) while the value of high yielding 'CIM Sheetal' variety is 6 – 7 cm. (Singh et al., 2005). According to Singh et al. (2005) thickness of leaf is an indicator of the gel content in leaves. Leaf thickness differed significantly among the accessions and ranged from 1.76 cm to 0.80 cm. Considerably thick leaves were produced by the accession AV-2 while the accession AV-25 was generally thin leaved.

Fresh weight of leaf, which is an important yield contributing character in aloe, also showed significant variation among the accessions. The average fresh leaf weight ranged from 59.00 g to 195.00 g in the thirty accessions. Almost same range was observed in the final observation. The accessions possessing higher fresh leaf weights in initial and final observations were AV-2, AV-16 and AV-13. These accessions also recorded highest values for biometric characters like leaf length, leaf breadth, leaf thickness and leaf weights, leading to higher fresh weight.

It was observed that the accessions produced leaves at significantly varying intervals with the period ranging from 26.40 to 48.00 days. Lowest leaf

production interval was observed in AV-7, AV-20 and AV-6. Accession AV-6 produced large sized leaves also. It can be noted that in the accession AV-18, the leaf production interval was more, it produced smaller sized leaves, and poor yield in both observations. Hence, it can be assumed that accessions like AV-25, AV-11, AV-27, AV-1 and AV-23 are genetically poor accessions with less yield potential (Fig.3). With regard to sucker production, the accessions AV-16, AV-20, AV-19, AV-17, AV-13, AV-18, AV-14, AV-22, AV-8 and AV-15 were found to be superior to others (Fig. 4). The results thus suggest that from the existing germplasm superior aloe land races could be selected. Such variation indicated scope for improving the population for these characters as reported earlier by Singh et al. (2005).

5.1.2 Anatomical Characterization

Aloe has strongly cuticularised leaves, having spiny margin with thin walled tubular cells. Chandukar (1989) reported that, taken along with other characters like morphology, cytology and embryology, anatomical characters help in taxonomic studies considerably. Anatomical study of germplasm showed that the leaf cuticle thickness varied from 6µm in AV-30 to 6.36µm in AV-1 and significant variation was observed among accessions. The number of stomata per square millimeter had no significant variation among accessions and majority of the accessions have one stomata per square millimeter (Plates 10 -12). Gahreman et al. (1998) reported that stomatal occurrence and stomatal index are most useful anatomical characters for taxonomic purpose.

The number of stomata present in the epidermis of the leaf depends upon the environmental conditions under which the leaf has developed (Meyer and Anderson, 1952). As the experiment was conducted in one location no significant difference was observed in the present study as far as stomatal count is concerned. Similar result was reported by Daunay (1986) in brinjal varieties. There was significant variation in mesophyll thickness among accessions. Mesophyll thickness was the highest for AV-2 (1.22 cm) followed by AV-1. As the mesophyll contributes to the gel content of leaf accessions, AV-2 and AV-1 can be considered as high gel yielding types. Light and electron microscopic studies

Plate 10 Upper portion of leaf showing cuticle epidermis and mesophyll cells (100x)

Plate 11 Mesophyll cells (100x)

Plate 10

Plate 11

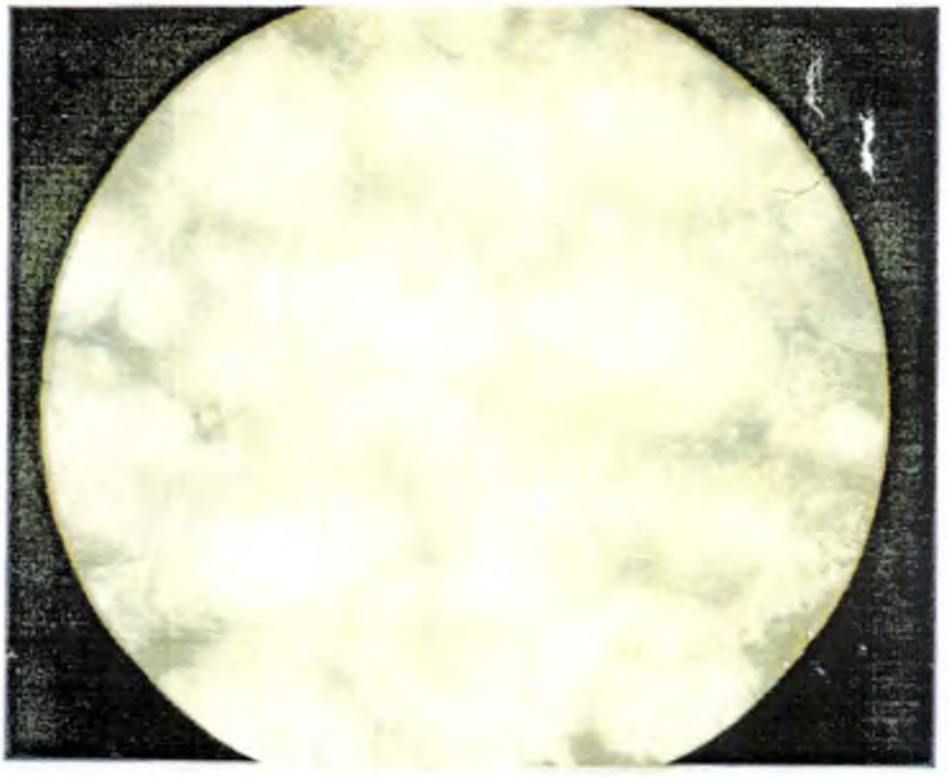


Plate 12 (12a, 12b and 12c) Dumbel shaped stomata of *Aloe vera*

Plate 12a

Plate 12b

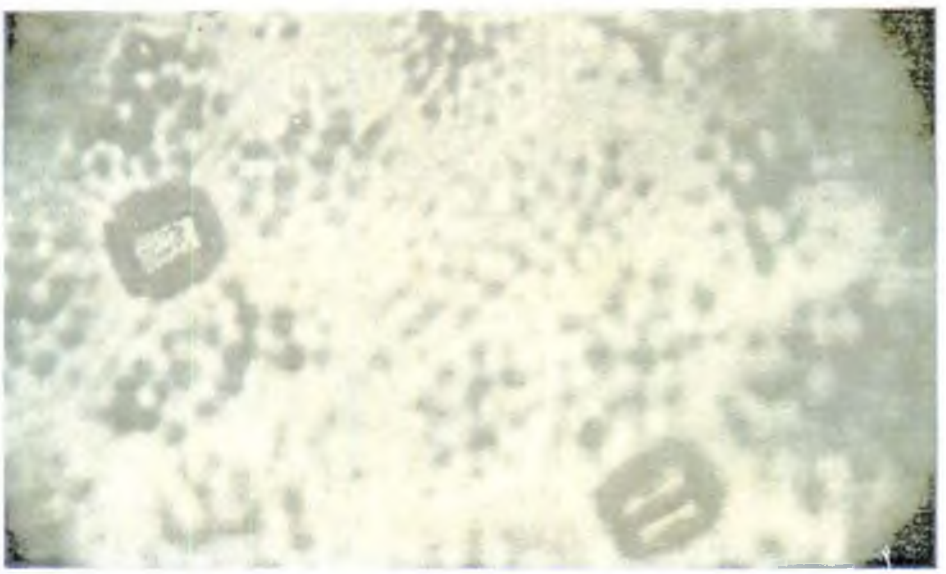


Plate 12c

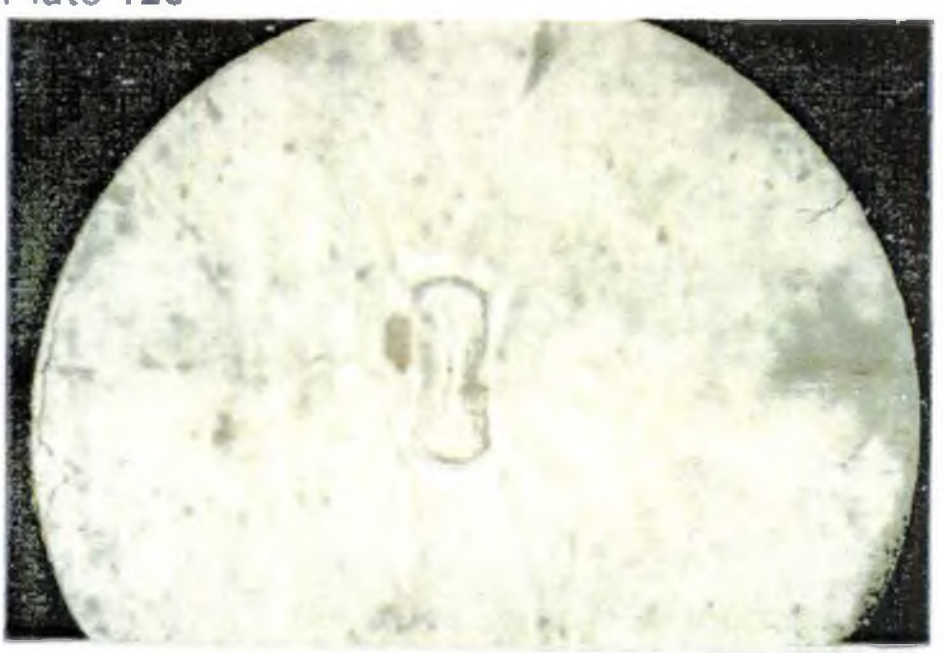


Fig. 3 Variation in phyllocrone in 30 accessions

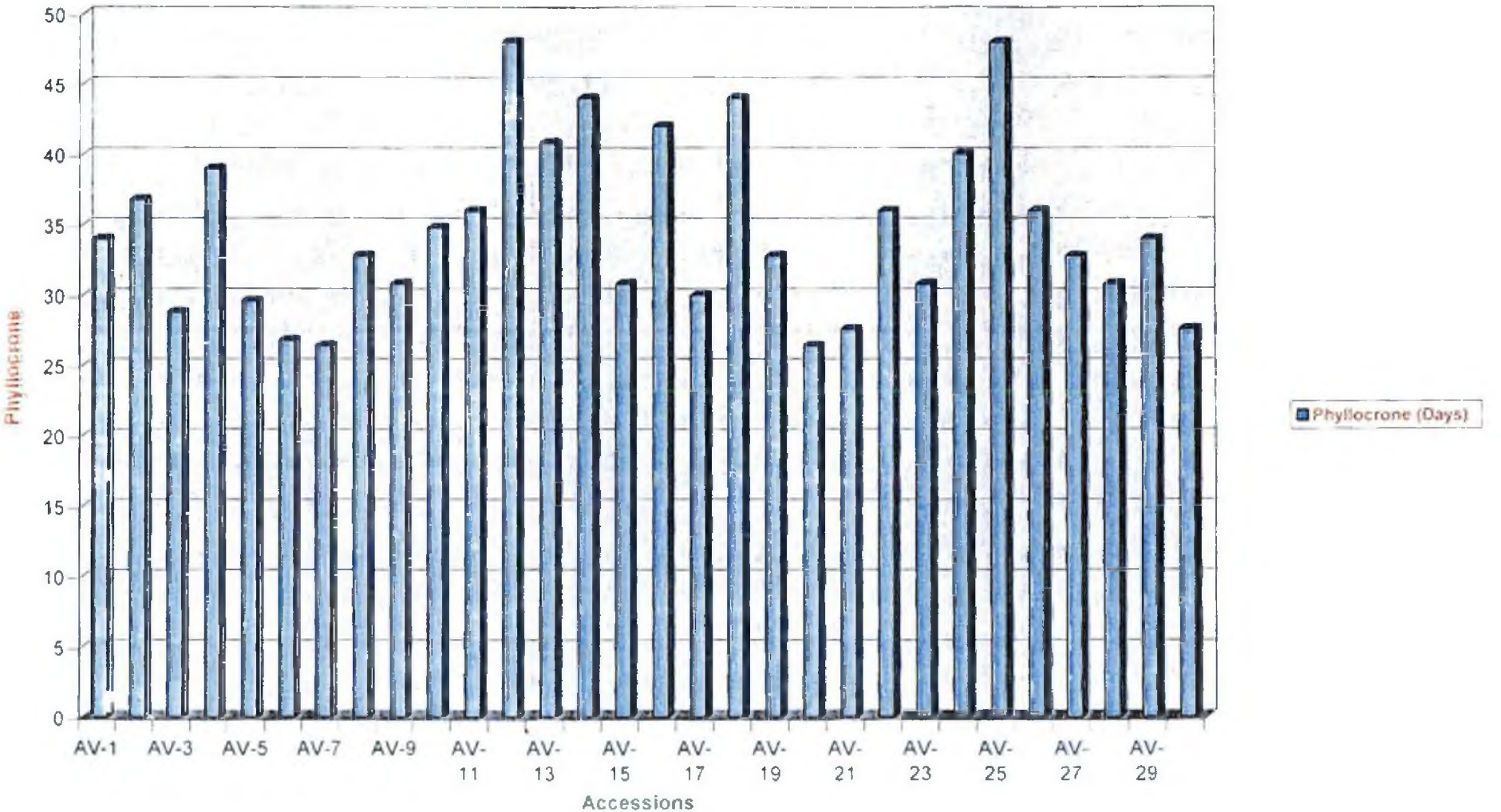
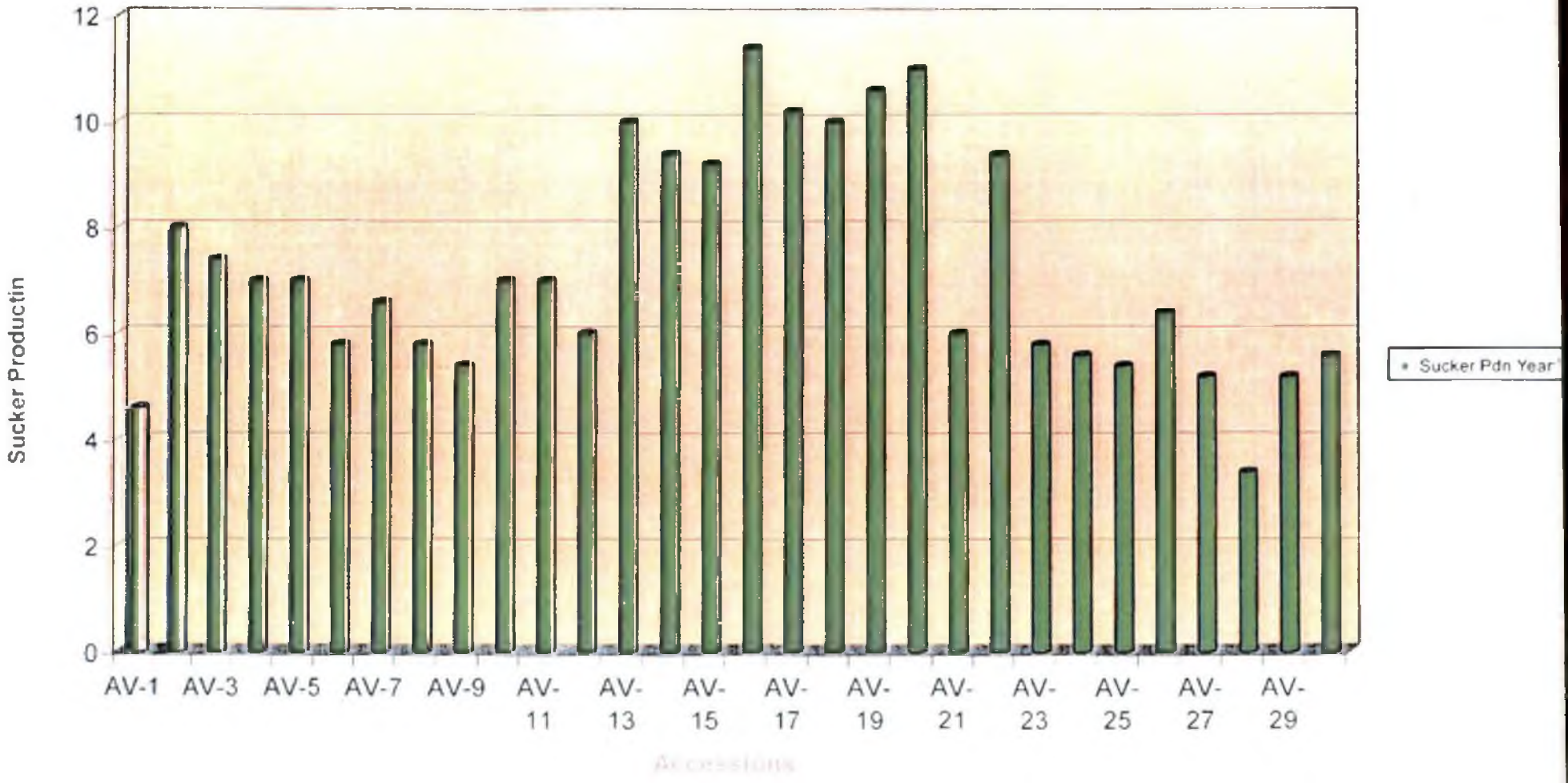


Fig. 4 Veriation in sucker production in 30 accessions of *Aloe vera*



conducted by Ni et al. (2004) have shown that the pulp consisted of large clear mesophyll cells with a diameter as large as 1000 micron. These cells were composed of cell wall and cell membrane along with a very limited number of degenerated cellular organelles and no intact cellular organelles were found in mesophyll cells. Isolation of the components of the gel by sequential centrifugation indicated that the gel consisted of two components *viz.*, thin clear sheets, micro particles and a viscous liquid gel, which corresponded to cell wall, degenerated cell organelles and liquid content of mesophyll cells.

5.1.3 Biochemical Characterization

Raina (1996) reported that aminoacid content in *Aloe vera* was 798.17 mg 100 g^{-1} FW. In the present study phytochemical analysis of the germplasm revealed that total free amino acids varied from 172 mg 100 g^{-1} in AV-17 to 644 mg 100g^{-1} FW in AV-25. Almost same range was observed one year after planting. During the initial and final evaluation AV-25 recorded maximum aminoacid content followed by AV-18 and AV-5, while AV-17 showed minimum aminoacid content.

Aloe gel, the commercially important constituent of mucilage is a polysaccharide with equal amount of glucose and mannose with small amount of uronic acid. The gel is widely used in various medical, cosmetic and nutraceuticals applications. The polysaccharides present in the gel are presumed to play a key role in the clinical activity of the gel (Yaron, 1993). In Indian aloe population, it varies from 1.33 to 2.51 mg ml^{-1} of mucilage extract (Handa and Kaul, 1996). In the present analysis also the total sugars showed significant variation among accessions which varied from 3.546 g 100 g^{-1} FW in AV-29 to 5.664 g 100 g^{-1} FW in AV-18 in the initial analysis while in the final analysis the range was from 3.564 g100 g^{-1} FW in AV-29 to 4.884 g 100 g^{-1} in AV-18. Yaron (1993) reported that the polysaccharides constituted 0.2 – 0.3 % of fresh gel.

The healing properties of *Aloe vera* is basically a result of the three anti-inflammatory fatty acids namely, cholesterol, campesterol and β-sito-sterol due to which it is highly effective for treating burns, cuts and many inflammatory

conditions of the digestive system and other internal organs. It naturally alkalizes digestive juices to prevent over acidity – a common cause of indigestion. It helps cleanse the digestive tract by exerting a soothing balancing effect (Yamaguchi et al., 1993). In the present study, free fatty acids content showed significant variation among accessions and it ranged from 2.254 mg oleic acid 100 g^{-1} FW in AV-6 to 3.694 mg oleic acid 100 g^{-1} FW in AV-18 in the initial observation. It varied from 2.332 mg oleic acid 100 g^{-1} FW in AV-6 to 3.498 mg oleic acid 100 g^{-1} FW in AV-18 in the final observation. Therefore, in both the observations AV-6 showed maximum fatty acids content followed by AV-5 and AV-25.

Vitamin A also showed significant variation among accessions and it varied from 54.068 mg 100 g^{-1} FW in AV-2 to 125.732 mg 100 g^{-1} FW in AV-5 in the initial analysis and almost same range was observed in final analysis. AV-5 recorded maximum vitamin A content, while AV-2 showed lowest vitamin A content. Vitamin C content varied from 16.184 mg 100 g^{-1} FW in AV-2 to 36.209 mg 100g^{-1} FW in AV-5 in the initial observation and almost same range was maintained one year after planting. In the final observation vitamin C content varied from 17.136 mg 100 g^{-1} FW in AV- 2 to 34.304 mg 100 g^{-1} FW in AV-5. The maximum vitamin C content was present in AV-5 while AV-2 showed least vitamin C content.

The role of some inorganic elements like vanadium, zinc, sodium, potassium, calcium, copper, manganese etc in the improvement of impaired glucose tolerance and their indirect role in the management of diabetes mellitus are being increasingly recognized. Hence, in the present study an attempt has been made to analyse the inorganic elements present in *Aloe vera* leaf gel. The results clearly indicated the presence of several mineral elements in the gel showing wide variation among accessions. According to Rajasekaran et al. (2005) the presence of various trace elements in the gel might account for the hypoglycemic nature of the plant.

Sodium content showed wide variation among accessions and it varied from 0.016 g 100g^{-1} FW in AV-6 to 0.127g 100g^{-1} FW in AV-25 during the initial analysis and almost same range of 0.016 g 100g^{-1} FW in AV-6 to 0.116 g 100g^{-1}

FW in AV-25 was observed one year after planting. During the initial and final analysis, AV-25 showed maximum sodium content and AV-6 showed lowest sodium content. Potassium content also showed wide variation among accessions and it varied from 0.058 g $100g^{-1}$ FW in AV-16 to 0.205 g $100g^{-1}$ FW in AV-18 in the initial analysis and almost same range was observed during the final analysis with 0.060 g 100 g^{-1} FW in AV-16 to 0.281 g 100 g^{-1} FW in AV-24. During the initial and final observation AV-18 recorded maximum potassium content and the least potassium content was in AV-16.

Calcium content varied from 0.017 % in AV-12 to 0.060 % in AV-25 during the initial analysis and almost same range was noticed one year after planting. During the initial evaluation, AV-25 recorded maximum calcium content and the lowest calcium content was for AV-12 followed by AV-16 and AV-6. In the final evaluation, maximum calcium content was noted in AV-9 and AV-25 and the lowest calcium content was observed in AV-16. Magnesium content also showed wide variation among accessions and it varied from 0.022 % in AV-9 to 0.033 % in AV-25 in the initial observation and not much change was observed one year after planting. During the initial and final observations, AV-25 recorded maximum magnesium content and the lowest magnesium content was observed in AV-1 in the initial analysis and AV-12 in the final analysis.

Iron content also showed wide variation among accessions and the iron content varied from 0.122 % in AV-1 and AV-16 to 0.464 % in AV-25 in the initial observation. In the final observation it varied from 0.134 % in AV-2 to 0.434% in AV-25. During the initial and final observation, AV-25 showed maximum iron content.

Saponins are natural soapy cleansers with antiseptic properties, which are excellent for cleansing the skin. The saponin content of accessions in the present investigation ranged from 0.83 % to 1.22% in the initial observation and almost same range was maintained one year after planting. During the initial evaluation, AV-5 recorded maximum saponin content followed by AV-25 and AV-18 while AV-9 recorded lowest saponin content. In the final observation, AV-25 recorded maximum saponin content and the lowest saponin content was recorded in AV-9.

Enzyme activity also showed significant variation among accessions. Peroxidase activity varied from 0.208 g minute^{-1} in AV-10 and AV-16 to 0.686 g minute^{-1} in AV-25 in the initial observation and it varied from 0.243 g minute^{-1} in AV-1 to 0.617 g minute^{-1} in AV-5 in the final observation. When topically applied aloe peroxidase may scavenge H_2O_2 in the skin surface and thus having probable role in skin protection as reported by Esteban et al. (2000). Poly phenol oxidase activity also showed wide variation among accessions, it varied from 0.103 g minute-1 to 0.417 g minute-1 in the initial observation, and 0.103 g minute^{-1} to 0.364 g minute^{-1} in the final observation. The maximum polyphenol oxidase activity was shown by AV-25, AV-18 and AV-5 in both the observations and the lowest polyphenol oxidase activity was observed in AV-14.

Since biosynthesis of active principles are regulated genetically and various factors affect the biosynthetic pathway, large variability was shown by the collections of aloe, which can be utilized for evolving a desired type (Handa and Kaul, 1996).

5.2 YIELD

Yield is an important character of a crop, which varies with genotypes and species. In the present study, the leaf yield showed significant variation among the accessions and it varied from 0.599 to 2.922 kg plant^{-1} year^{-1}. The accessions AV-24 (2.92 kg) and AV-6 (2.79 kg) were superior in leaf yield. Other accessions, which produced higher yields, were AV-15, AV-30, AV-13 and AV-3. Singh et al. (2005) also reported wide variation in Aloe leaf yield ranging from 0.278 to 2.45 kg.

The latex yield also showed significant variation among accessions and it varied from 12.56 to 31.46 g plant^{-1} year^{-1}. The maximum latex yield was obtained from AV-6 followed by AV-2, AV-12 and AV-21 and the least latex yield was obtained from AV-1 followed by AV-5 and AV-11. Yield contributing parameters like leaf length, leaf breadth and leaf thickness were high in these accessions. Considering both leaf and latex yield, AV-6 emerged as the most promising accession.

5.3 VARIABILITY

An insight into the magnitude of variability present in a crop species is of utmost importance as it provides the basis for effective selection. The observed variability in the population is the sum total of the variations that arise due to genotypic and environmental effects. Information on the nature and magnitude of variability present in a population owing to genetic and non-genetic causes is an important pre requisite for starting any systematic breeding programme. Only the genetic proportion of total variability contributes to gain under selection. Therefore, knowledge of the genetic variation governing the inheritance of quantitative characters like yield and its components is essential in any crop plants (Allard, 1960).

In the present investigation, for majority of characters, magnitude of PCV and GCV were closer, suggesting greater contribution of genotype rather than environment. So selection can very well be based on the phenotypic values. Such a closer PCV and GCV for different characters were earlier reported by Prasanna et al. (1994) in *Marjorana hortensis* and Singh et al. (1999) in *Mentha spicata.*

From the forgoing discussion, it is clear that the characters *viz.* plant height, plant spread, leaf length, leaf breadth, leaf thickness, leaf weight, leaf yield and latex yield offer good scope for selection among the present collection of aloe accessions .

5.4 PAIRED t- TEST

Results of the study revealed that the accessions registered significant positive change with respect to biometric characters like plant height, plant spread, leaf length, leaf width, leaf thickness and biochemical constituents.

5.5 CORRELATION STUDIES

Yield is a complex character, which is the outcome of a number of genetic factors and environmental condition, which are inter related at various stages of plant growth. Therefore, selection made for this character merely on the basis of its phenotypic expression, is likely to be misleading. Hence, analysis of yield in terms of genotypic, phenotypic and environmental correlation coefficients of the component characters leads to better understanding of them and form a basis of

selection. The genotypic correlation between characters provides a reliable measure of genetic association between characters and help to differentiate the vital association useful in breeding from the non-vital ones (Falconer, 1981).

Based on the results of the present study it is evident that, in general, the genotypic correlations are higher than phenotypic correlation as reported by Singh et al. (1999) in spear mint. Leaf length, leaf thickness, leaf breadth and leaf weight are identified as the main yield contributing factors in aloe (Singh et al., 2005). In the present investigation, plant height, plant spread, leaf length, leaf breadth, leaf thickness and leaf weight showed positive association with leaf yield and latex yield. It reveals the importance of predicting yield of aloe by applying selection on these characters in advance.

5.8 SELECTION INDEX

Selection index provides information on yield components and thus aids in the indirect selection for improvement in yield. Discriminant function analysis developed by Smith (1936) gives information on the proportionate weightage to be given to an yield component. Thus, selection index was formulated to increase the efficiency of selection by taking in to account the important characters contributing to yield. Further, Hazel (1943) suggested that selection based on a suitable index was more efficient than individual selection for character. Upon ranking selection index scores obtained, the accession AV-16 ranked first followed by AV-12, AV-2 and AV-6 for morphological characters alone. Accession AV-5 ranked first followed by AV-25, AV-18 andAV-23 for biochemical characters alone and AV-12 ranked first followed by AV-16, AV-13 and AV-6 by considering both morphological and biochemical characters for selection.. The accessions AV-16, AV-12, AV-2 and AV-6 were found superior based on morphological characters and morphological and biochemical characters together.

Association between morphological, biochemical and yield contributing characters revealed that morphological characters like plant height, plant spread, leaf length, leaf breadth, leaf thickness and leaf weight showed positive

association with leaf yield and latex yield. So these characters offer good scope for selection among the present collection of aloe accessions.

A location specific evaluation has to be carried out with these aloe accessions in areas with diverse agro climatic situations for evolving a suitable variety. These locally adapted landraces could be exploited in future breeding programmes for combining their superior characteristics to otherwise high yielding varieties.

SUMMARY

6. SUMMARY

A study on "Collection, characterization and evaluation of *Aloe vera* (L.) Burm.f. germplasm" was carried out at the College of Agriculture, Vellayani from April 2006 to March 2007. The objectives of the study were to characterize the aloe germplasm collected from various geographical conditions, based on morphological, anatomical and biochemical variability and to select promising ecotypes.

Thirty diverse accessions of aloe were collected from various locations of Kerala and Tamil Nadu. Preliminary evaluation of reference sample plants of each accession were done in terms of morphological and biochemical characters. One year after planting morphological, anatomical and biochemical characterisation and association between morphological, biochemical and yield contributing characters were worked out and the accessions were evaluated based on these results.

Statistical analysis of morphological parameters such as plant height, plant spread, leaf length, leaf breadth, leaf thickness, leaf weight, leaf shape, leaf colour, phyllocrone and suckering were carried out for each accession. Accession AV-2 recorded maximum plant height, plant spread, leaf breadth, leaf thickness and leaf weight. Lowest phyllocrone was recorded by AV-7 and highest sucker production was recorded by AV-16.

Anatomical studies of the accessions revealed that there was significant variation in mesophyll thickness among accessions. AV-1 recorded the maximum cuticle thickness. Mesophyll thickness was the highest for AV-2, which indicates higher gel yield potential. The number of stomata per square millimeter had no significant variation among accessions and majority of the accessions have one stomata per square millimeter. Leaf cuticle thickness varied from 6µm in AV-30 to 6.36µm in AV-1 and significant variation was observed among accessions.

Biochemical characters such as amino acids, total sugars, fatty acids, vitamin A and C, saponins, minerals such as sodium, potassium, calcium, magnesium and iron content exhibited significant difference among the different

accessions. AV-18 recorded maximum total sugar content, calcium content and total free fatty acid. AV-25 recorded maximum amino acid, Vitamin C, sodium and magnesium content. AV-24 recorded the highest potassium content. Activity of enzymes like peroxidase and polyphenol oxidase also showed wide variation among accessions and accession AV-25 showed significantly higher PO and PPO activity. The saponin content of accessions in the present investigation ranged from 0.83 % to 1.22% in the initial observation and almost same range was maintained one year after planting. AV-25 recorded maximum saponin content.

The highest leaf yield was obtained from AV-24 and AV-6 and highest latex yield was obtained from AV-6 (31.46 g $plant^{-1}$ $year^{-1}$) and was on par with AV-2 (24.37 g), AV-12 (22.75 g) and AV-21 (22.32 g).

Paired t test between the initial and final yield and quality contributing factors revealed that there was significant and positive changes in the morphological, biochemical and yield contributing characters of the accessions.

Association between morphological, biochemical and yield contributing characters revealed that morphological characters like plant height, plant spread, leaf length, leaf breadth, leaf thickness and leaf weight showed positive association with leaf yield and latex yield. So these characters offer good scope for selection among the present collection of aloe accessions.

Biochemical constituents were positively correlated with each other and negatively correlated with morphological characters.

Discriminant function analysis was carried out for isolating superior accessions of *Aloe vera* based the morphological (10 characters) and biochemical characters (13 characters). Upon ranking based selection index scores, the accession AV-16 ranked first followed by AV-12, AV-2 and AV-6 for morphological characters alone. Accession AV-5 ranked first followed by AV-25, AV-18 and AV-23 for biochemical characters alone and AV-12 ranked first followed by AV-16, AV-13 and AV-6 by considering both morphological and biochemical characters for selection. . The accessions AV-16, AV-12, AV-2 and AV-6 were found superior based on morphological characters and morphological and biochemical characters together.

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* Orginal not seen

APPENDIX

APPENDIX

1. Weather parameters during experimental period

Sl. No.		Max. Temp. °C	Min. Temp. °C	R.H Per cent	Rain fall mm	Rainy days
April	2006	32.78	25.46	80.92	34.30	3
May	2006	31.70	25.21	83.38	267.50	11
June	2006	31.19	24.21	84.98	217.80	7
July	2006	29.91	23.73	83.77	158.60	7
August	2006	30.05	23.58	86.53	111.70	9
September	2006	30.18	23.07	86.33	379.00	16
October	2006	30.06	22.80	88.25	594.00	21
November	2006	30.31	22.78	87.56	221.20	11
December	2006	31.4	21.8	83.20	6.00	1
January	2007	31.90	21.00	78.24	0.60	0
February	2007	31.80	21.20	77.10	2.20	0
March	2007	34.80	23.42	76.60	0	0

APPENDIX -II

Analysis Of Variance – Plant Height (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	14082.63	485.6078	26.66687 **
Error	120	2185.219	18.21016	
TOTAL	149	16267.84		

Analysis Of Variance- Plant Height (1 YAP)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	13488.75	465.1293	32.62396 **
Error	120	1710.875	14.25729	
TOTAL	149	15199.63		

Analysis Of Variance – Plant Spread (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	3.456215	0 .1191798	12.16122 **
Error	120	1.175999	9.799989E-03	
TOTAL	149	4.632214		

Analysis Of Variance – Plant Spread (1 YAP)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	3.264843	0.1125808	19.2285 **
Error	120	.7025871	5.854893E-03	
TOTAL	149	3.96743		

Analysis Of Variance – Leaf Length (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	5169.797	178.2689	13.55979 **
Error	120	1577.625	13.14688	
TOTAL	149	6747.422		

Analysis Of Variance – Leaf Length (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	4704.203	162.2139	17.7394 **
Error	120	1097.313	9.144271	
TOTAL	149	5801.516		

Analysis Of Variance – Leaf Breadth (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	81.53174	2.811439	11.32205 **
Error	120	29.79785	0 .2483154	
TOTAL	149	111.3296		

Analysis Of Variance – Leaf Breadth (1 YAP)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	85.02832	2.932011	12.41829 **
Error	120	28.33252	0.2361043	
TOTAL	149	113.3608		

Analysis Of Variance – Leaf Thickness (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	5.827729	0.2009562	7.387904 **
Error	120	3.264084	0 .0272007	
TOTAL	149	9.091812		

Analysis Of Variance – Leaf Thickness (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	6.117676	0.2109544	9.292521 **
Error	120	2.724182	2.270152E-02	
TOTAL	149	8.841858		

Analysis Of Variance – Leaf Weight (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	162983.1	5620.108	21.76035 **
Error	120	30992.75	258.2729	
TOTAL	149	193975.9		

Analysis Of Variance – Leaf Weight (1 YAP)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	132039	4553.069	20.62604 **
Error	120	26489.25	220.7438	
TOTAL	149	158528.3		

Analysis Of Variance – Phyllocrone (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	6667.438	229.9116	2.647124 **
Error	120	10422.41	86.85339	
TOTAL	149	17089.84		

Analysis Of Variance – Phyllocrone (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	5648.203	194.7656	3.088416 **
Error	120	7567.594	63.06328	
TOTAL	149	13215.8		

Analysis Of Variance – Sucker Production Per Year

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	666.6733	22.98874	5.438973 **
Error	120	507.2002	4.226669	
TOTAL	149	1173.874		

Analysis Of Variance – Number Of Stomata

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	1.26001	4.344861E-02	0.7241438
Error	120	7.199997	5.999998E-02	
TOTAL	149	8.460007		

Analysis Of Variance – Cuticle Thickness

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	1.258301	4.338968E-02	1.571389 *
Error	120	3.313477	2.761231E-02	
TOTAL	149	4.571778		

Analysis Of Variance – Epidermal Thickness

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	67.44141	2.325566	.7751886
Error	120	360	3	
TOTAL	149	427.4414		

Analysis Of Variance – Mesophyll Thickness

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	3.907715	0.1347488	7.117195 **
Error	120	2.271942	1.893285E-02	
TOTAL	149	6.179657		

Analysis Of Variance – Amino Acid (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	2.411774	8.316461E-02	184.9641 **
Error	120	5.395508E-02	4.496257E-04	
TOTAL	149	2.465729		

Analysis Of Variance- Amino Acid (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	2.371727	8.178369E-02	202.7818 **
Error	120	4.839707E-02	4.033089E-04	
TOTAL	149	2.420124		

Analysis Of Variance – Total Sugars (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	16.02319	0.552524	311.441 **
Error	120	0.2128906	1.774089E-03	

TOTAL	149	16.23608		

Analysis Of Variance – Total Sugars (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	16.02319	0.552524	311.441 **
Error	120	0.2128906	1.774089E-03	
TOTAL	149	16.23608		

Analysis Of Variance – Fatty Acids

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	23.05652	0 .7950524	48.18547 **
Error	120	1.979981	1.649984E-02	
TOTAL	149	25.0365		

Analysis Of Variance – Fatty Acids (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	19.41602	0.6695178	66.55504 **
Error	120	1.207153	1.005961E-02	
TOTAL	149	20.62317		

Analysis Variance – Vitamin A (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	50893.38	1754.944	90.54368 **
Error	120	2325.875	19.38229	
TOTAL	149	53219.25		

Analysis Variance – Vitamin A (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	45492.19	1568.696	115.4647 **
Error	120	1630.313	13.58594	
TOTAL	149	47122.5		

Analysis Of Variance Vitamin C (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	2880.336	99.32193	11.06234 **
Error	120	1077.406	8.978385	
TOTAL	149	3957.742		

Analysis Of Variance – Vitamin C (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	3281.641	113.16	9.358059 **
Error	120	1451.07	12.09225	
TOTAL	149	4732.711		

Analysis Of Variance – Saponins (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	1.627213	5.611078E-02	102.1702 **
Error	120	6.590271E-02	5.491892E-04	
TOTAL	149	1.693115		

Analysis Of Variance – Saponins (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	1.20903	0.0416907	60.61545 **
Error	120	8.253479E-02	6.8779E-04	
TOTAL	149	1.291565		

Analysis Of Variance – Sodium (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	0.117983	4.068378E-03	57.88868 **
Error	120	8.433521E-03	7.027934E-05	
TOTAL	149	0.1264165		

Analysis Of Variance – Sodium (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	0.1050214	3.621428E-03	479.7275 **
Error	120	9.058714E-04	7.548929E-06	
TOTAL	149	0.059273		

Analysis Of Variance – Potassium (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	0.1728627	5.960781E-03	340.7917 **
Error	120	2.098918E-03	1.749098E-05	
TOTAL	149	0.1749616		

Analysis Of Variance – Potassium (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	0.2809881	9.689244E-03	1.901872*
Error	120	0.6113501	5.094584E-03	
TOTAL	149	0.8923382		

Analysis Of Variance – Calcium (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	1.331313E-02	4.590735E-04	61.34791 **
Error	120	8.979738E-04	7.483115E-06	
TOTAL	149	0.0142111		

Analysis Of Variance – Calcium (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	1.765494E-02	6.087911E-04	1.50189
Error	120	0.048642	4.0535E-04	
TOTAL	149	6.629694E-02		

Analysis Of Variance –Magnesium (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	1.274057E-03	4.393299E-05	24.09639 **
Error	120	2.187863E-04	1.823219E-06	
TOTAL	149	1.492843E-03		

Analysis Of Variance – Magnesium (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	1.15858E-03	3.995104E-05	25.12324 **
Error	120	1.908243E-04	1.590202E-06	
TOTAL	149	1.349405E-03		

Analysis Of Variance – Iron (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	1.818108	6.269336E-02	380.7448 **
Error	120	1.975918E-02	1.646598E-04	
TOTAL	149	1.837867		

Analysis Of Variance – Iron (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	1.377658	4.750545E-02	323.9348 **
Error	120	1.759815E-02	1.466513E-04	
TOTAL	149	1.395256		

Analysis Of Variance PO (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	2.634354	9.083978E-02	34.47802 **
Error	120	0.3161659	2.634716E-03	
TOTAL	149	2.95052		

Analysis Of Variance PO (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	1.540436	5.311848E-02	34.39717 **
Error	120	0.1853123	1.544269E-03	
TOTAL	149	1.725748		

Analysis Of Variance PPO (Initial)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	1.262708	4.354165E-02	29.36533 **
Error	120	0.1779308	1.482757E-03	
TOTAL	149	1.440639		

Analysis Of Variance PPO (Final)

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	0.7566843	2.609256E-02	15.28547 **
Error	120	0.2048421	1.707017E-03	
TOTAL	149	0.9615264		

Analysis Of Variance – Leaf Yield

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	45.54718	1.570592	56.75732 **
Error	120	3.320648	2.767207E-02	
TOTAL	149	48.86783		

Analysis Of Variance – Latex Yield

Source	D.F	S.S	M.S.S	F
TREATMENTS	29	2283.328	78.73545	13.63515 **
Error	120	692.9336	5.774447	
TOTAL	149	2976.262		

COLLECTION, CHARACTERIZATION AND EVALUATION OF *Aloe vera* (L.) Burm. f. GERMPLASM

ABHILA.S.R

Abstract of the
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ABSTRACT

The present study titled "Collection, characterization and evaluation of *Aloe vera* (L.) Burm.f. germplasm" was conducted at the Department of Plantation crops and spices, College of Agriculture, Vellayani, during the period April 2006 – March 2007.

Thirty diverse accessions of aloe were collected from various locations of Kerala and Tamil Nadu. Preliminary evaluation of reference sample plants of each accession were done in terms of morphological and biochemical characters. A final evaluation of morphological, anatomical and biochemical characters were carried out one year after planting in the new environment and association between morphological, biochemical and yield contributing characters were worked out and the accessions were evaluated based on these results.

The accessions recorded significant variation for morphological characters like plant height, plant spread, leaf length, leaf breadth, leaf thickness, leaf weight, leaf shape, leaf colour, phyllocrone and suckering.

Study of the anatomical characters of the accessions like number of stomata, cuticle thickness, epidermal thickness and mesophyll thickness revealed that there was no significant variation among the accessions with regard to number of stomata and epidermal thickness. Significant difference existed in mesophyll thickness and it was the highest for AV-2 and hence maximum gel yield.

Wide variation in biochemical characters such as amino acids, total sugars, fattyacids, vitamin A and C, saponins, minerals such as sodium, potassium, calcium, magnesium and iron content and activity of enzymes like peroxidase and polyphenol oxidase were noticed among the thirty accessions.

Yield analysis of the accessions revealed that AV-16, AV-12, AV-2, AV-6, AV-13, AV-30, AV-29, AV-15, AV-9 and AV-7 had superior yield contributing characters. The accessions having superior biochemical characters are AV-5, AV-25, AV-18, AV-23, AV-11, AV-21, AV24, AV-27, AV19 and AV-26, hence are superior in quality. By combining yield contributing and quality

characters accessions AV-12, AV-16, AV-13, AV-6, AV-15, AV-2, AV-30, AV-19, AV-29 and AV-14 were found to be superior.

The accessions AV-16, AV-12, AV-2 and AV-6 were found superior based on morphological characters and morphological and biochemical characters together. Association between morphological, biochemical and yield contributing characters revealed that morphological characters like plant height, plant spread, leaf length, leaf breadth, leaf thickness and leaf weight showed positive association with leaf yield and latex yield. So these characters offer good scope for selection among the present collection of aloe accessions. A location specific evaluation has to be carried out with these aloe accessions in areas with diverse agro climatic situations for evolving a suitable variety.