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**CARIBBEAN
FOOD
CROPS SOCIETY**

*SOCIETE CARAIBE
POUR LES PLANTES ALIMENTAIRES*

25

Twenty fifth
Annual Meeting 1989

25^e CONGRES ANNUEL

Guadeloupe

Vol. XXV

THE INTRODUCTION OF *ALOE VERA* TO TOBAGO AS A COMMERCIAL CROP

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ABSTRACT

The co-operation between the Caribbean Industrial Research Institute (CARIRI), the Caribbean Agricultural Research and Development Institute (CARDI) and the Tobago House of Assembly in preliminary research work on *Aloe vera* led to the development of a Co-operative which now processes *Aloe vera* gel commercially. Current research and future perspectives are summarized. The future of this innovation work is linked to opening of market, complementary to the locally existing ones (drinks, yoghurt...), above all for export (cosmetic products, freeze-dried gel), to improvement of fertilization and weeding while monitoring the residues, and also to diversifying the activities of the cooperative.

RESUME

L'INTRODUCTION D'*ALOE VERA* A TOBAGO POUR UNE CULTURE COMMERCIALE

La coopération entre l'Institut de Recherche Industriel Caraïbe (CARIBI), l'Institut de Recherche et de développement Agricole Caraïbe (CARDI) et la Chambre de l'Assemblée de Tobago, conduit, à partir d'un travail de recherche préliminaire, à la mise en place d'une Coopérative qui traite aujourd'hui commercialement du gel d'*Aloe vera*. La recherche en cours et les perspectives prochaines sont résumées. L'avenir de cette innovation tient à l'ouverture de marchés complémentaires à ceux existants localement (boissons, yaourt...) notamment en exportation (cosmétique, gel congelé), à l'amélioration de la fertilisation et du désherbage en surveillant les résidus et aussi à la diversification des activités de la coopérative.

One of the main problems facing agricultural development in Tobago is the lack of agro-industries. Tobago's population is only about 40,000, and shipping, which has to be through Trinidad, is difficult although improved airport and harbour facilities are now being built. Without processing operations the market, even for traditional crops is limited, and is extremely risky for non-traditional crops.

The work described here was the beginning of a continuing attempt to address this problem through the development of a small-scale agro-industry which could service a market demand and provide import substitution - in this case by primary processing of *Aloe vera* gel.

Aloe vera has generated increased interest in recent years for many reasons. The effect of a cut leaf of *Aloe vera* applied to a sprain, bruise or wound is quite dramatic. It also provides rapid relief of burns. Taken internally in juice, eggnog or aloes wine, *Aloe vera* is renowned in Tobago as a tonic. The «bitter aloes» which drains from the leaf is a purgative too strong to be in general use these days.

In Trinidad and Tobago, Seaforth (1983) and Pavy (1988) between them cite over 40 conditions for which *Aloe vera* is used as all or part of the folk treatment: Honychurch (1986) also refers to the use of *Aloe vera* for some of the same ailments wounds, colds, menstrual problems, diabetes - in Barbados, Jamaica and other parts of the Caribbean.

Internationally, *Aloe vera* is best known as the source of aloin, the purgative, but Martin (1961) gives many other examples of its use from around the world. These include treatment for burns and other skin problems, for colds and chest ailments, for ulcers and tumours and against some infectious diseases such as tuberculosis. It is also used as an insect repellent.

Some of these diverse claims appear to be more well founded than others. Clinical studies have shown that «aloes» does indeed have properties related to some of its folk uses, for example, records of antibiotic activity and wound-healing hormone activities are reported by Morton (1961). Gupta (1972)

in a study showing improved fertility and menstrual functioning under treatment with aloes coincidentally observed an improved sense of «well being and improvement in health» lending credence to its local use as a tonic. The Food and Drug Administration of the U.S.A. have approved aloes tablets for the treatment of high blood pressure.

The cosmetic uses of *Aloe vera* become well appreciated, as a skin moisturizer

and hair conditioner for example, and cosmetic manufacturers in Trinidad are using scarce foreign exchange to import stabilized gel.

THE *Aloe vera* PROJECT IN TOBAGO 1985 - 1988

Cooperation

CARIRI as part of a project funded by Trinidad and Tobago's Industrial Development Corporation (IDC), initiated work on *Aloe vera* in 1985. The first steps in cementing a rewarding network of co-operation followed. CARIRI, having identified Tobago as a suitable site, requested the assistance of the Head of the Planning Division of the Tobago House of Assembly, and through him, CARDI, since CARDI works closely with the Tobago House of Assembly and takes responsibility for agricultural research in Tobago. The Tobago House of Assembly provided field facilities, labour and contributed in many other ways. Other agencies also lent their support as summarized in Table 1.

Agronomy

Planting material

The planting material (suckers) obtained from all sources (Tobago, Trinidad, Dominica) appears to be an identical cultivar fitting the description of *Aloe barbadensis* Mill. (syn. *A. vera* L.) :

Succulent plants of the family Liliaceae. Stems stout supporting a close rosette of fleshy sword-like, upturned leaves grey-green, white at the base, about 50 cm long, 10 cm wide at the base tapering to a slender tip, flat on the upper surface, rounded on the lower ; margins spiny, the spines strong, short, curved. Juvenile leaves streaked and dotted with narrow white lines. Epidermis rubbery with a sub-epidermal layer of longitudinal cells containing a bright yellow latex. The parenchyma, or «pulp» is mucilaginous and semi-transparent. The erect unbranched flower stalk becomes approximately 100 cm tall with a 30 - 40 cm raceme of pendent tubular yellow 2 - 5 cm flowers (Morton 1961).

Propagation was always from suckers. Early attempts to propagate from leaf and root pieces were unsuccessful. Seaforth (1983) states that this species does not fruit. During the study seed-like structures were observed but these have not produced plants either in the field nor under nursery care. Preliminary investigations are being made on propagation, through tissue

Table 1 :Agencies co-operating in the Aloe vera project in Tobago, 1985 - 1988

Co-operating agency	Contribution
Industrial Development Corporation (IDC)	Research finance Processing unit (rental) Business guidance
Caribbean Industrial Research Institute (CARIRI)	Industrial R & D
Caribbean Agricultural Research & Development Institute (CARDI)	Agricultural R & D
Tobago House of Assembly	
Planning Division	Co-ordinating original project proposal
Agricultural Division	Field facilities, labour etc. Provision of State lands to Co-operative
Co-operatives Division	Business Advice
Ministry of Food Production	Diagnostic services
Canadian High Commission	Equipment grant

culture, by the University of the West Indies (UWI) using material from Tobago. This will be followed up as a student project.

Collection and establishment

During 1985 - 1988 aloe plants were collected, maintained and propagated at Kendal Farm School, Tobago, for the purpose of supplying CARIRI with sufficient material for processing studies and to collect agronomic information in order to advise future commercial expansion.

Early in 1985 planting material was scarce. Plants were collected from March 1985 and a plot of 325 plants was established by September 1985 which served as a source of leaves for CARIRI.

Some losses - approximately 10 % - occurred when the first collection of plants were transferred from bags to the field in 1985. These losses could be attributed to three main factors :

- small (<20 cm high) plants perished more easily than bigger plants
- soil sometimes fell into, or was washed by heavy rains into the centre of the plant. This led to rapid rotting.
- poor soil drainage.

Since then plants have been kept in a nursery until they are at least 20 cm high. Special attention has been paid to ensuring that the heart of the plants remains soil-free during cultural operations.

In July 1987 the collection was expanded in anticipation of increased demand for nursery plants and to provide plots for further agronomic work. Large suckers from the first plot were transferred directly to a second site. Smaller suckers from the original plot were put into an undercover nursery bed at Goldsborough Demonstration Station. These increased in height from an average of 8.3 cm to 29.9 cm in April 1988 when they were transferred to the field. One thousand plants were also brought in from Dominica, about a third of which were lost as a result of damage during shipping.

Crop management

A spacing of 0.6 m x 0.6 m was used in the original plot but after observing growth habit and response to harvesting a spacing of 0.3 x 0.6 m has been adopted.

Weeds were controlled manually every 1-2 months as required. This would be very labour demanding on a large scale and was identified as an area

requiring further research.

Traditionally very little fertilizer is used on *Aloe vera* even under commercial production. In keeping with common practice low levels of fertilizer were used during the life of the project but this was also identified as an area requiring study. The first plot was planted with pen manure, but subsequently this has been discontinued to avoid the risk of faecal contamination of the end product which is used as food.

Only two side dressings to fertilizer (150 kg/ha 13:13:20) were used, at 5 and 17 months after establishment, after which regular harvest of leaves began. Since June 1988 regular 3-monthly applications of fertilizer (150 kg/ha of 13:13:20) have been applied.

In the area of pest and disease control two major problems were encountered :

Nematodes

Nematode counts were requested from the Ministry of Food Production when root damage was noticed in the plots. This root damage caused symptoms similar to those due to drought stress - a reddish colouration and shrivelling of the leaves - and causes plants to succumb more rapidly to drought stress than healthy plants.

Nematode counts were high. *Xiphinema* sp., an ectoparasite, was found in soil from both plots sampled, at one site the population density was 2,800/l soil. *Rotylenchulus reniformis*, was also detected (6,800/l soil). *Xiphinema* was identified as the most probable cause of the root damage, and hence crop loss. Established plants were treated with Vydate.

Leaf rot

Towards the end of the dry season of 1988 conditions favoured the widespread incidence of *Fusarium* leaf rot. Once again the Ministry of Food Production identified the causal organism. Outbreaks occurred in many areas of Tobago and were apparently unrelated. Weakened patches appeared on the epidermis which were yellow at first but rapidly turned black/brown causing all or part of the leaves to shrivel.

Affected plants were treated with Benlate. Heavy losses of leaves occurred but most plants survived and regenerated.

Irrigation was required although aloe can tolerate drought to some extent,

having a thick epidermis and although the root systems is shallow it can utilize sparse surface water.

In short periods of drought growth virtually ceases and gel production is greatly reduced. Leaf tips shrivel and leaves look noticeably thinner. These leaves will «catch back» when water becomes available. However under exceptionally severe conditions a critical point is reached - as occurred in the dry season of 1987. After approximately 8 weeks of drought the plants changed dramatically in appearance. The whole leaves shrivelled and took on a strong reddish tinge. Some leaves with this appearance could not revive when water was restored. (It has since then been realised that these symptoms were exacerbated by nematode damage to the roots).

After this experience irrigation facilities were installed and have since proved invaluable for promoting rapid stress-free establishment of new plots and for maintaining gel production.

Mature, healthy aloes can grow in full sun. However, observations indicate that some shade promotes maximum gel production and facilitates establishment of young plants. Plots planted in 1988 were established under saran netting which was gradually removed.

Harvesting

Leaves suitable for processing should be at least 40 cm long, preferably longer, and weigh 0.2 kg or more. Plants took a year to develop from suckers to this size. The approximate height of mature plants was 55 cm.

The leaf of the aloe plant is attached to the stem at two points at the side of the leaf. To minimize damage to the leaf and reduce possible contamination, the leaf is severed as near to these two points as possible.

After one year as many as ten leaves had been reaped from one plant. Subsequently three or four leaves per plant are harvestable every 3 to 4 months.

Yield of gel

Over the period December 1984 to February 1986, the yield of blended, filtered gel obtained from leaves harvested in Tobago varied from approximately 63 to 48 % and the yield of raw gel containing fibres from 65 to 52 %. Although weather conditions were atypical over this period there was a definite correlation between yield of gel and rainfall with lowest yields being obtained during the drier months.

Table 2 : Nematode population in Aloe vera plots in Tobago, February 1988

Nematode spp	Nematode count		
	Plot 1	Plot 2	
	No. / litre of soil	No. / 100 g roots	No. / litre of soil
Xiphinema sp.	2800	-	933
Peltamigratus sp.	533	-	533
Rotylenchulus reniformis	-	-	6800
Meloidogyne sp.	-	1600	133
Total	3333	1600	8399

Table 3 : Annual variable costs and returns of growing Aloe vera, Tobago

	Labour use (man days)	Cost (tt\$/1 000 plants)
Land preparation *	-	10
Planting *	0,5	30
Bed and drain formation and maintenance	-	19
Fertilizing		
- material	-	42
- labour	0,5	30
Weed control		
- chemicals	-	14
- labour	1,5	90
Harvesting	5	300
Total variable costs		535

* Every five years

This correlation of gel yield and rainfall was substantiated by the results obtained from leaves harvested under particularly dry conditions in Paramin, Trinidad when the yield of fibreless gel dropped to 38 %.

The viscosity and bitterness of the gel was also directly related to seasonal conditions. Low gel yield was invariably associated with an increase in the viscosity and bitterness and a change in pH from 5.1 in gel harvested during the rainy season to 4.3 for highly viscous gel obtained during the dry season.

The preliminary results obtained in this study indicate the necessity to develop standards for gel intended for use in a food product. Standards of viscosity were established for gel obtained from high yielding leaves harvested during the rainy season and more viscous gel was diluted to this viscosity to maintain the desired sensory characteristics for the *Aloe vera* product.

These results also indicate the necessity for irrigation during the dry season to maintain the quality of the gel.

Feasibility Study

The figures in Table 3 have been calculated for production of *Aloe vera* based on the management of the plots used in this project.

COMMERCIAL DEVELOPMENT

Formation of the Tobago Agro-industrial Co-operative

Once the potential for commercial exploitation of this and other aspects of the CARIRI/IDC project were confirmed, Kendal Farm School graduates were identified as a possible group to take up the production challenge.

One of the main objectives of the Kendal Farm School in Tobago has been to produce farmers after an 18-month practical-oriented course. The students are young, usually 17 - 22 years old, who have either a background in agriculture or can demonstrate their interest in the subject.

Unfortunately many of the graduates, especially the women, find their options for farming limited by lack of resources-especially land or finance.

It was felt that their involvement in their own agro-industry could provide them with a means to use their training, pool their resources and offer each

other mutual support.

Several meetings of graduates were held from July 1987 as the idea took shape. The Co-operatives Officer of the Tobago House of Assembly was called in and asked to explain the differences between the formation of a Co-operative and other types of business.

Eventually it was decided that a Co-operative would meet the needs of the group mainly because :

- Only a small capital input is required from each individual
- The democratic principles of the Co-operative movement were attractive.
- Co-operative would provide strength in numbers when seeking outside assistance.

The initiative taken by this group of young people was appreciated and outside assistance was indeed forthcoming. Major inputs were made by the Canadian High Commission towards the purchase of equipment and by the Tobago House of Assembly through the allocation of Statelands for crop production. The IDC leased a unit in their «Multi-producers Mall» in Tobago under the arrangement which included a 6 months moratorium and a gradually increasing rent. The Co-operative Division, Tobago House of Assembly, has continued to give guidance which has been especially in the field of management have been taken through courses run by the Management Development Centre as this is recognized to be an area requiring attention.

The Tobago Agro-industrial Co-operative (TAIC) was registered in December 1987 with 14 founder members. There are now 18 members some of whom are active in production, others in processing.

Markets

The present market is based on supplying a Trinidad food manufacturer with *Aloe vera* gel for inclusion in a health food. Knowing the popularity of *Aloe vera* locally as a tonic CARIRI formulated this health food comprising fruit cordial - passion fruit, orange and grapefruit so far- and *Aloe vera* gel mixed in a gelatine base.

This product was enthusiastically accepted in its testing stage by one of the large food processors in Trinidad who have the chilled yoghurt-type plant required to handle and package this product.

Consumer acceptance tests were made by CARIRI itself with over 2000

favourable responses, followed by test marketing through retail outlets from July 1988.

Production increased this year (1989) and since a promotion package is planned in the near future this market is expected to expand even more. Guava and tamarind flavours will also be used in the expansion.

Crop Production

In the absence of any market for *Aloe vera* very little was previously grown, except one or two plants for home use.

Increased production will have to be undertaken by farmers who understand the uncertainties of the market : *Aloe vera* is a slow growing crop and in order to take advantage of increasing markets are not yet guaranteed.

Despite the risks involved production is increasing through two main avenues :

-The members of the Co-operative and their suppliers are increasing their individual production and the Co-operative has nursery plants sufficient to plant out approximately 0.2 ha on their shared land.

-Other interested farmers are being advised by CARDI, firstly on the market situation and secondly on crop production using a preliminary crop guide.

Estimated production at present, although greatly increased over the last year, is still relatively low, averaging a total of about 3,000 plants at several sites throughout Tobago.

Processing

The Co-operative is using a small-scale extraction method, developed by CARIRI to produce the *Aloe vera* gel.

Production at present is done on a weekly basis when approximately 300 leaves are processed. This is sufficient to meet the current market demand and has provided enough gel for the manufacture of over 30,000 cups of the commercial product, «Nutravera», up to June 1989.

Discussion

As a result of this work a market for *Aloe vera* exists where none did before. Future developments, however, depend primarily on the opening up of other

markets.

The TAIC has already contracted CARIRI to formulate cosmetic preparations to be produced exclusively by the Co-operative. These are expected to be on the market early in 1990.

Export markets exists both for the cosmetic products and for stabilized or freeze-dried gel as an input into other industries. CARIRI is currently investigating these alternative methods of gel preservation. Gel production for export would be a large-scale, large investment operation beyond the current means of this Co-operative. This kind of investment is more likely to be made in Trinidad but if so it could also benefit Tobago's new industry by providing another market for aloe leaves, processed gel and nursery plants.

In the field, CARDI is refining the production package by evaluating herbicide and fertilizer use. Glyphosate herbicide, over-top, as used in the U.S.A. and elsewhere, appears to be more effective than other easily available treatments (Gramoxone, Fusilade, Glyphosate applied with a weed wiper). More investigations are required on chemical residues since this material is used in a food product. Five fertilizer treatments are being compared and various parameters of crop production are being measured. One year's data will be compiled by December 1989. With this information included in the production package, on-farm evaluation will be conducted.

Further studies are planned in which the chemical composition, pH, viscosity and amount of fibrous material in the gel will be monitored to determine optimum conditions for the cultivation of *Aloe vera* designed as a source of gel for use in food, toiletry and cosmetics processing.

Meanwhile the Co-operative is expected to be diversifying its products this year. Dried herbs and a liquid seasoning will be the first of many other ideas to be commercialized.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the assistance of Selby Quashie of CARDI, Rahzia Mohammed-Maraj of CARIRI and the staff of the Tobago House of Assembly, particularly Alan Richards and Neville Guy of the Planning Division, R. Phillips, Technical Officer of the Division of Agriculture and the Principal, L. Archer, and staff of Kendal Farm School, Tobago.