CFC COMMON FUND FOR COMMODITIES

INIAP INSTITUTO NACIONAL AUTONOMO DE INVESTIGACIONES AGROPECUARIAS

ICCO

INTERNATIONAL WORKSHOP

"Project to establish physical, chemical and organoleptic parameters to differentiate between fine and bulk cocoa"

PROCEEDINGS

Trinidad and Tobago
January 31st – February 2nd 2001

Project to establish the physical, chemical and organoleptic parameters to differentiate between fine and bulk cocoa

Proceedings of the workshop to establish working procedures

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Since there is no accepted way of distinguishing fine or flavour from bulk cocoa, the proportion of the total production by a particular country which is classified as fine or flavour cocoa is pre-set and may not reflect reality. Most of the Caribbean Islands produce 100% fine or flavour cocoa, but production from other countries such as Ecuador, Papua New Guinea and Venezuela is split between the bulk and fine or flavour classification. This situation is unsatisfactory from many viewpoints. There is a possibility of high quality fine or flavour cocoa being included in the bulk quota and visa versa. The absence of good criteria to classify the beans will tempt for farmers to "dilute" fine or flavour cocoa with bulk beans to take advantage of the premium price. Manufacturers can reject consignments of beans on the grounds that they don't like them, rather than through a well defined and quantifiable method of assessing their quality.

The main purpose of the project we will be discussing over the next three days is to define criteria to distinguish fine or flavour and bulk cocoas. The purpose of this workshop is to initiate the project and to define common working procedures for the project participants. However the workshop should have other objectives, not just that of defining working procedures.

As participants of this project, we have many problems in common and other problems that are specific to our particular situation. During this workshop, we have opportunity to share each other's problems and to discuss possible solutions. An important objective of the workshop is to get to know each other and learn about the strengths and weakness of all the participants. This will lead to good and effective working relationships, which should develop during the execution of the project. We can take advantage of the broad spread of expertise gathered here, exchange ideas, learn from each other and provide support where it is needed.

With these few words of encouragement, I wish you all success in your deliberations over the next three days and throughout the life of the project.

It is my understanding that the world community generally classifies cocoa beans into two broad categories. The first consists of what is regarded as "bulk" beans used in the manufacture of cocoa butter and high-volume chocolate lines. The second category consists of what is regarded as "fine or flavour" cocoas used to make premium dark chocolates and high quality couvertures where the special qualities of such cocoas can be fully appreciated.

Cocoa has long been a part of the history of Trinidad and Tobago especially after the opening up of the island for plantation development in the 1780's. The introduction of the Criollo (native) cocoa tree into Trinidad is said to have occurred around 1575, the Spaniards reported the discovery of the tree in the island in 1617, suggesting that it had not been widely cultivated up to that time. However, it was not until the beginning of the 18th century that cocoa first became a staple product of Trinidad.

In 1727 much of the cocoa in Trinidad was destroyed by a 'blast', which may have been a hurricane or an epidemic outbreak of a pest or disease. Some 30 years later Trinidad obtained planting material of the darker-beaned cocoa of the Amazonian Forastero (foreign) type. This hybridised with the remnants of the original white-beaned Criollo introduction, to produce what is referred to as "Trinitario" (native to Trinidad) cocoas. Trinidad and Tobago is therefore internationally recognised as the centre of origin for "Trinitario" germplasm and an exclusive producer of fine or flavour cocoa.

Despite many mixed fortunes, both buyers and manufacturers speak proudly of the distinguished "marks" imported from some plantations in the 1950's and 1960's. Today, Trinidad and Tobago is still a source of fine or flavour cocoa beans and continues to receive a significant premium above the world market price. There continues to be a demand for cocoa beans from Trinidad and Tobago, especially from Europe and North America. This demand exceeds our present modest production levels.

The market for fine cocoa is directly linked to the consumption of premium quality dark chocolate products made from these beans. During the 1980's there was a decline in the market share for fine or flavour cocoa since the general low price of cocoa caused many smaller confectionery and commodity trading companies to be taken over by larger more corporate entities. Such companies produced high volume chocolate from bulk beans and had little interest in paying for fine or flavour cocoas. The use of fine or flavour cocoa in the recipes of these companies was gradually being phased out.

Within recent times, however, there has been resurgence in the demand for fine or flavour cocoas with subsequent growth in that market sector. This is in response to rising standards of living and increased preference for superior products This has led to the development of "origin specific" dark chocolates, "certified organic" brand dark chocolates and Fair Trade endorsed and certified chocolates. Consumers are prepared to pay more for these "specialised" chocolate products.

These collections provided the impetus for Freeman's work which proceeded from the 1950's to the 1980's and produced high yielding Trinidad Selected Hybrid (TSH) varieties with large beans and large pods combined with resistance to witches' broom disease.

It is important to note that apart from other agronomic considerations, Freeman also had as a major objective of his breeding programme, the maintenance of the renowned flavour of Trinidad and Tobago cocoa. The resulting TSH clones combined with a closer spacing can give high yields of fine or flavour cocoa and the continuing drive for better suited germplasm in all agronomic facets continues to this day with CRU and the MFPMR working in close collaboration.

It is my understanding that your task at hand lies in that fact that there is an absence of universally accepted and clear criteria for determining whether a bean falls into the category of "bulk" cocoa or into that of "fine or flavour" cocoa. This can complicate the market situation in what can be considered a lucrative and expanding market.

The problems experienced in the fine or flavour market are certainly not unique to Trinidad and Tobago and each project member country is faced with its own unique set of problems. However, the presence of the various participants from Ecuador, Papua New Guinea, Venezuela and Trinidad and Tobago highlight your unified approach towards dealing with this problem that affects each and every fine or flavour cocoa producer.

The Ministry of Food Production and Marine Resources recognises that the benefits of what you are setting out to do will accrue to all in the production chain - from the farmer to confectionery. It is fitting therefore that representatives from all the links in the production chain are present here today. I urge this gathering to work together, let the research be "need driven". Let it meet the needs of the industry.

The international scientific co-operation fostered by this project highlights the importance of the task at hand. The foresight of the ICCO with the generous support of the CFC along with the combination of international research expertise and resources will go a long way towards arriving at a positive and mutually agreeable solution. I wish you well.

The Ministry of Food Production and Marine Resources will continue to participate in and support projects of this nature and the research efforts of CRU. We recognise the critical role CRU plays both in the conservation and utilisation of cacao genetic resources for global cocoa production and also the critical supporting role that CRU can play, as evidenced by this project, in finding solutions to both local and international production, processing and marketing problems. These solutions will go a long way towards revitalising this sector and strengthen the historical marketing position that we as fine or flavour cocoa producers hold so proudly.

Ladies and Gentlemen, I thank you!

markets, enhancing the long-term competitiveness and prospects of particular commodities, and assisting them to function effectively in a liberalised global economy.

The Common Fund applies a commodity focus, which is designed to ensure that all Common Fund financed projects address general problems of a commodity and are therefore of wider interest and benefit to a larger range and number of countries. Through this multi-country "commodity focus", in co-operation with other development institutions, the private sector and civil society, the Fund endeavours to achieve overall efficiency and to increase its impact in commodity development.

The Common Fund's projects typically seek to alleviate poverty through a variety of project based initiatives focused on the development of commodities, on which a large number of the poorest people depend for their livelihood. This commodity focus is intended to ensure that projects are in the interests of all stakeholders engaged in the production, processing, marketing and trade of commodities and that a particular group of producers do not gain at the expense of others, or at the expense of consumers.

For this reason, before the Fund can consider financing a project, the project has to be formally endorsed and sponsored by an International Commodity Body (ICB). An ICB comprises representatives, at the governmental level, of both producing and consuming countries that collectively account for a significant share of world trade in the commodity concerned. The Fund co-operates with 24 International Commodity Bodies (ICBs) and in this respect, I am delighted that we also have a representative from the International Cocoa Organisation, Jean Marc Anga, at this meeting. The complete list of the 24 designated ICBs, including names, addresses and points of contact are contained in Annex VI of the "Basic Facts on the Common Fund for Commodities", some of which have already been distributed, but additional copies are also available from the CFC Secretariat.

The Common Fund concentrates its activities on commodities of importance to Least Developed Countries for good reason. As I am sure you are aware, many developing and Least Developed Countries are heavily dependent on commodities, which form the backbone of their economies and account for the bulk of their export earnings. In this context, the Common Fund deals with a core issue at the heart of development, in seeking to contribute, through its projects, to the international agenda for poverty alleviation, sustainable development and to facilitate an increase in private sector involvement in commodity development measures.

The aims of CFC financed projects are to respond to the changing structures and constraints affecting world demand and supply situations and the future outlook for commodities. This brief overview also includes examples of ongoing projects financed by the Common Fund in the cocoa sector, designed to address the principal constraints, problems and opportunities for the sector, and contribute to potential solutions in collaboration with key stakeholders and potential project partners. Worldwide it is estimated that of the 2.4 billion people who are employed in agriculture in Developing access and new product development; vertical and horizontal diversification; and assistance to more effectively integrate into the increasingly liberalised world markets. A stronger commodity sector supports the competitive position and prepares the foundations for the extension of economies into other products and industries. The long-term decline in real price trends for many commodities and deteriorating terms of trade makes it even more important to identify new opportunities to add value at origin. Over the last two decades, the decline in the terms of trade has been sharper for most Latin American countries than for other regions of the world.

Globalisation and liberalisation, through inward investment and capital, can contribute to improve market access for products from Latin American and Caribbean countries, opening up new markets and export opportunities, however, it also increases the competition for resources and the weaker players in the market, more often producers in developing countries, can quickly become more marginalised. The identification of market opportunities, analysis of problems and constraints, and measures to resolve them with key stakeholders and the focus on the poorer strata of populations are all critical factors considered in the definition, formulation, appraisal and design of projects financed by the Common Fund.

Other measures to foster commodity development and improve structural conditions in markets, to enhance long-term competitiveness and prospects for commodities, include research and development; productivity and quality improvement; technology transfer; diversification and processing; new product and market development and market access. In terms of measures to assist developing countries to more effectively function in a liberalised global economy, current projects include physical market development, enhanced market infrastructure, private sector initiatives and commodity price risk management. Examples of projects of this type promote the use of warehouse receipts as collateral for trade credit in grains, coffee, cocoa, and cotton.

Loan funded projects usually require the generation of revenues over and above the costs, so that the loan can be repaid. This is often more difficult to achieve in research type projects, which tend to predominate at the pre-harvest level. There may be more opportunities for loan funding in the other two categories of projects. To ensure that the Common Fund's projects are relevant to the interests of several countries, and to maximise any direct gains, the Common Fund typically supports projects that have operating sites for implementation in two or more countries.

Specific provisions are also made in the project budget to cover the financing required for dissemination of project results, findings and recommendations to other countries, which are also dependent on the commodity in question. This "commodity focus" is unique since the majority of bilateral and multilateral development and funding agencies typically view projects from either a national or a single country perspective. By contrast, the Common Fund's approach ensures that projects benefit several countries, including producers and consumers, and cut across national boundaries. In pursuing this commodity focus, the CFC's Governing Bodies have instructed the Secretariat that an

Cocoa Marketing and Trade Improvement; and Price Risk Management for Cocoa Farmers.

The Project for Generic Cocoa Promotion in Japan sought to overcome some of the negative perceptions frequently associated with cocoa and chocolate consumption and to publicise the positive health benefits like high its polyphenol content, through advertising and promotional activities in the mass media. The Project for Pilot Plants to Process Cocoa by-products in Ghana sought to develop commercially applicable by-products from cocoa wastes, including soaps and cosmetics from cocoa butter, animal feeds from pelletised cocoa pods and husks, potash from incinerated cocoa pods and husks, jams, pectin and marmalades from cocoa sweatings, and cocoa wine, gin and brandy from fermented alcohols. The Cocoa Germplasm Project seeks to enhance co-operation and collaboration in cocoa research and development through enhancing the genetic resources across the three main cocoa producing regions of the world including Africa, Southeast Asia and Latin America. The ultimate aim is to identify and select traits for increased productivity, higher yields, pest and disease resistance. The Project for the Use of Molecular Biology Techniques in a Search for Varieties resistant to Witches' Broom Disease seeks to develop and release new cocoa plant varieties, which are more productive and more tolerant to witches' broom disease. The project will use molecular markers genetic linkage maps and to speed up the breeding process. The Project for the establishment of the Physical, Chemical and Organoleptic Parameters to Differentiate between Fine and Bulk Cocoa seeks to provide universally acceptable criteria to differentiate between fine or flavour and bulk cocoa through a series of scientific evaluations of the physical, chemical and organoleptic analyses and develop instruments and methodologies to test the characteristics. The Project for the Improvement of Cocoa Marketing and Trade in Liberalising Cocoa-Producing countries seeks to improve cocoa quality, to enhance market and price information systems and transparency and improve the marketing chain through transaction risk reduction and structured trade finance focused on warehouse receipts, collateral management and legal and policy reforms. The Pilot Project for Price Risk Management for Cocoa Farmers seeks to provide cocoa farmers with access to price risk management instruments to reduce their vulnerability to fluctuations in world market prices and stabilise their incomes derived from growing cocoa. The project is designed to test the feasibility and use of various price risk management options for use by small groups of farmers, local traders and exporters.

These projects are being executed by a large variety of PEA's in the private and government sectors, including the Cocoa and Chocolate Association of Japan (CCAJ); Cocoa Research Institute Ghana (CRIG); IPGRI (through CIRAD and INIBAP Montpellier); CEPLAC Brazil; GtZ Germany; and INIAP in Ecuador. The beneficiaries include consumers and producers alike in cocoa exporting countries through increased demand; through added value and productivity; increased yields, pest and disease resistance and productivity; cocoa producers, traders and exporters through enhanced market transparency and improved access to trade finance. The direct beneficiaries in countries of implementation include Brazil, Cameroon, Costa Rica, Côte d'Ivoire,

The Role of the International Cocoa Organisation as Project Supervisory Body

J.M. Anga

International Cocoa Organisation

Permanent Secretary, Mr. Chairman, Distinguished Guests, Ladies and Gentlemen,

On behalf of Dr. Edouard Kouame, the Executive Director of the International Cocoa Organisation, I would like to welcome you all at this inaugural workshop for the "Project to Establish the Physical, Chemical and Organoleptic Parameters to Differentiate between Fine and Bulk Cocoa".

Firstly, I would like to acknowledge the invaluable contribution of all participating institutions and in particular the generous assistance received from The CFC, represented here by Mr. Mark Clayton.

The ICCO is indeed delighted to be associated with this important project which is to establish clear, unambiguous and widely accepted criteria to distinguish between different categories of cocoa beans, thus allowing those which fulfil the required standards of quality or flavour, to earn a higher premium on the market.

In a world which is becoming a global village and increasingly dominated by large, integrated companies, it is crucial to ensure that small farmers can receive a fair remuneration for their hard work. That is why a project which provides instruments to determine the quality of the cocoa produced and which helps the farmers to secure a higher premium on the market, seems to be welcome. The ICCO is very pleased to play a role in achieving this outcome.

But before coming to ICCO's role as Supervisory Body, please allow me to say a few words about the organisation, which I have the honour to represent today.
The ICCO works for the world cocoa and chocolate sector and was created in 1973 under the auspices of the United Nations and has 42 members

Exporting members

Benin	Malaysia
Brazil	Nigeria
Cameroon	Papua New Guinea
Côte d'Ivoire	Peru
Dominican Republic	São Tomé and Principe
Ecuador	Sierra Leone
Gabon	Togo
Ghana	Trinidad and Tobago

ICCO also operates a cocoa information centre via its library and web site: http://www.icco.org

Finally statistics and information on cocoa are also provided via Quarterly Bulletin of Cocoa Statistics, The World Cocoa Directory, Cocoa Newsletter and Country studies

The ICCO organisational structure comprises the International Cocoa Council, the ICCO Secretariat and the Executive and Finance Committee. Other sub committees include the Production Committee, the Consumption Committee. There are several working groups such as the Advisory Group on the World Cocoa Economy, Expert Working Group on Research and Environment, Expert Working Group on Quality and finally the Expert Working Group on Stocks.

As you have seen from this short presentation, an important aspect of our work is to formulate and to assist institutions in our member-countries to develop project proposals in the cocoa sector for submission to potential donors.

Over the years, we have acquired and developed considerable expertise in project formulation, monitoring and supervision and we have been putting it at the disposal of our member-countries. I would be pleased to discuss any possible help in this respect to any interested party during this meeting.

Now, I am coming to our role in this project: In general terms, we regard our role of Supervisory Body more as a facilitator than that of a "policeman". We are here to help the PEA and the participating institutions to implement the project without undue constraints and assist them in any problem which may arise and if necessary to act as an intermediary with the Common Fund for Commodities. These functions and responsibilities of ICCO as the Supervisory Body are contained in the Final Appraisal Report and in the Project Agreement signed in March 2000 between CFC, ICCO and INIAP.

Without going into too much technical detail, this role consists of supervising and monitoring the implementation of the project. In so doing, we have a duty to examine all information submitted by the Project Executing Agency (in this case INIAP), with respect to the execution of the project, to assess whether the actions undertaken, the expenditures made and the results achieved conform with the provisions of the Project Agreement and lastly to consider the continued relevance of project activities as well as the prospects for its successful implementation and completion.

Our main duties therefore are:

- to act as a focal point for discussions relating to the future development of the project, including possible modifications to be made;
- to receive and analyse the six-monthly and annual reports submitted by INIAP and formulate regular supervision reports to CFC;

Project Objectives and the role of the Project Executing Agency/Terms of Reference for discussion sessions

F. Amores

Instituto Nacional Autónomo de Investigaciones Agropecuarias

Background and Introduction

In December 1996 a project entitled "Study of the chemical and physical parameters to establish the difference between fine and bulk cocoa" was submitted to CFC by ICCO, on behalf of INIAP. The project involved Ecuador, Papua New Guinea and Trinidad and Tobago. Later Venezuela expressed its desire to contribute to the project and was added as a fourth participating country.

The Executive Board of CFC approved on 28 October 1998 partial financing of the project. The Appraisal Report of CFC was released on 3 March 2000 and provided the basis for implementation of the project. The Project Agreement among CFC, ICCO and INIAP was signed on 20 March 2000. Memoranda of Understanding among INIAP and CRU (Trinidad and Tobago) and INIAP and CCRI (Papua New Guinea) were signed at the end of March 2000 and funds were made available in January 2001.

The fine or flavour cocoa market

The world cocoa market distinguishes between two broad categories of cocoa beans "fine or flavour" cocoa beans, and "bulk" or "ordinary" cocoa beans. The international cocoa agreement, 1993, recognises 17 countries as producers of fine or flavour cocoa. The share of fine or flavour cocoa in the world has fallen dramatically, from about 50% at the beginning of the century to just under 5% now. The Latin American and Caribbean region supplies 80% of the world's fine or flavour cocoa. Ecuador accounts for over half the total world production of fine or flavour cocoa.

Traditional cocoa consuming countries of Western Europe represent the largest consumer market for fine or flavour cocoa, however the United States of America and Japan are also notable users of this type of cocoa. Imports of fine or flavour cocoa beans range from 5% to 20% of total imports in these countries. Most major chocolate manufacturers have premium quality chocolate products in their range, the recipes of which require fine or flavour cocoa from specific origins.

Fine or flavour cocoa is generally regarded as a relatively small, highly specialised and separate to the bulk cocoa market, with its own supply and demand characteristics. Specialist agents buy directly from fine or flavour origins for specific chocolate companies. The price received is determined by the supply-demand balance for that particular origin and type of cocoa, with the quality and flavour requirements of the consumer being the primary considerations. Short terms factors influence the offers and

Project objective

The project aims to provide universally accepted criteria to differentiate between fine or flavour and bulk cocoa. To achieve this, the project proposes to evaluate the characteristics of fine or flavour and bulk cocoas, through a series of activities including physical, chemical and organoleptic analysis, and to provide parameters, methodologies, standards and instruments to be used in subsequent assessments. These outputs will help to make fine or flavour cocoa more competitive externally through market transparency and efficiency of trade, thus encouraging the development of fine or flavour cocoa industry.

Main outputs expected from the project

Reliable information on the physical, chemical and organoleptic characteristics that differentiate fine or flavour from bulk cocoa.
The methodology to measure and compare the main parameters which define the quality of fine or flavour cocoa.
Standards and instruments to evaluate the quality of fine or flavour cocoa.

General Methodology

In an internationally co-ordinated effort involving Ecuador, Trinidad and Tobago, Venezuela and Papua New Guinea, cocoa genotypes will be selected, from which samples will be taken. On these samples, fermentation and drying studies will be undertaken. Subsequently, physical, chemical and sensory analysis will be conducted. This will be complemented by DNA profiling and Spectral Image Analysis. Finally, results from all participants will be analysed and interpreted to arrive at conclusions regarding the differences between fine or flavour and bulk cocoa. Once this is achieved, useful quality standards for grading fine or flavour cocoa can be developed.

Project Components

Fermentation and drying trials

This component will lead to a range of qualitative parameters that are characteristic of fine or flavour and bulk cocoa, as well as preferences from various of manufacturers of the preferred fermentation regimes for different genotypes.

Chemical assessment of quality parameters

This component will provide quality parameters of representative samples of fine or flavour and bulk cocoa, which will be used in combination with other variables to differentiate between fine or flavour and bulk cocoa.

Cocoa liquor preparation and chemical analysis

This component will generate data to establish links between the flavours obtained from the cocoa liquors and different roasting regimes.

Project Information and Overview

D.R. Butler

Cocoa Research Unit

Introduction and Research Problem

Fine or flavour cocoa represents a very specialised niche on the international cocoa market with a demand pattern that is difficult to predict, but with a good potential for increasing in the medium term. The definition of fine or flavour cocoa remains controversial as there is no single universally accepted criterion that could be adopted as a basis for determining whether or not cocoa of a given origin is to be classified as fine or flavour cocoa.

Relevant criteria include:

- genetic origin of planting material
- morphological characteristics of the plant
- colour of the cocoa beans and nibs
- degree of fermentation, drying
- presence of off-flavours
- percentage of internal mould, insect infestation and
- percentage of impurities.

Many measurements do not reflect cocoa quality objectively in terms of taste or true flavour and chemical characteristics. This causes problems amongst chocolate manufacturers in standardising their products. A similar difficulty is shared by traders on the international market who base their decisions mainly on the degree of fermentation and genetic origin of cocoa.

Project Objectives

In this project, the research efforts of both current and historical leaders in fine or flavour cocoa production and research *viz.* Ecuador, Trinidad and Tobago, Venezuela and Papua New Guinea have been combined to address this important problem for producing countries.

Primary Objective

The primary objective over the three-year duration of the project is to develop the capacity of all involved in the cocoa sector to adequately differentiate between fine or flavour and bulk cocoa, thereby improving the marketing position of fine or flavour cocoa.

Component 1: Fermentation and Drying Trials

Objectives

- To obtain parameters of physical quality factors which will be used in conjunction with other variables to differentiate between fine or flavour and bulk cocoa.
- To obtain feedback from chocolate manufacturers on samples of dried beans with different fermentation regimes.

Output

- A range of parameters which characterise fine or flavour and bulk cocoas, from the samples analysed in the fermentation and drying trials.
- Preferences from a variety of chocolate manufacturers on the preferred fermentation regime for different genotypes.

Activities

- Select and collect representative samples from eight clones of cocoa genotypes from local collections and farms in each participating country.
- Carry out fermentation and drying trials on selected samples using methods traditionally used in each participating country. Sweat box fermentation and natural drying will be used in all countries.
- Record the progress of fermentation and drying processes through temperature measurements and monitoring of physical and titratable acidity.
- Determine the moisture content, carry out cut-tests, measure bean size and assess colour of nib.

Component 2: Chemical analysis of quality parameters

Objective

- To obtain parameters for chemical factors affecting the quality of representative samples of fine or flavour and bulk cocoa, which will be used in conjunction with other variables to differentiate between fine or flavour and bulk cocoa.

Output

- A range of chemical parameters which are characteristic of fine or flavour and bulk cocoas.

Activities

- Monitor and measure the fermentation index as an indirect measure of cocoa bean quality.
- Monitor and record physical and titratable acidity.
- Monitor and record levels of both volatile and non-volatile acids including organic acids.
- Determine butterfat content and melting point.
- Identify polyphenols together with anthocyanins and their components, tannin and theobromine content and alkyl pyrazine compounds using High Performance Liquid Chromatography (HPLC) methodologies.

Activities

- Obtain DNA profiles from cocoa genotypes used in the project with STMS.
- Analyse the spectral properties and other quality compounds of cocoa using Gas Chromatograph Coupled Mass-Spectrometry (GCMS) and Liquid Chromatograph Coupled Mass-Spectrometry (LCMS).

Component 5b: Analysis and Interpretation of results

Objective

- To establish clear and objective criteria to differentiate between fine or flavour and bulk cocoas.

Output

- A set of criteria and instruments to be used in differentiation of fine or flavour and bulk cocoas.

Activities

- Analyse and integrate the information gathered from the previous activities into a body of knowledge, with an aim to translate it into criteria to be used to differentiate between fine or flavour and bulk cocoas.

Total Project Benefits

The benefits from the project will emanate in terms of improved transparency and efficiency in the trade of fine or flavour cocoa. The quality of beans for manufacturers of premium dark chocolate will be more reliable and consistent, thereby improving the quality of products and possibly facilitating lower manufacturing costs. There will be clear guidelines for plant-breeders to select varieties with specific characteristics to meet certain preferences of the collaborating manufacturers. A guaranteed premium price could be established for farmers delivering a consistently high quality of fine or flavour cocoa.

Cocoa classification

Cocoa is generally classified into three major groups. a) Criollo cocoa, which is generally regarded as possessing the finest flavour attributes. These are the oldest cocoa varieties which were historically distributed by the Spaniards from Mexico to South and Central America after their conquest of the Americas. These cocoas have been taken to places as far away as the Philippine Islands. b) Bulk or basic flavour cocoa, which arise from the Forastero genotypes and account for 95% of current world cocoa production. Bulk cocoa is used as the base for high volume milk chocolate lines and is often mixed with other flavours and fillings. c) Trinitario cocoa represents a natural hybrid of genotypes in the above mentioned groups which produce intermediate or good flavours depending on the extent of cross breeding. This material has been widely distributed and is widely used in genetic improvement programmes due to its high yield and good fine or flavour characteristics.

The fine or flavour cocoa market

The fine or flavour cocoa market is cyclical with an overall (long-term) upward trend (Corning, 1992) which is disproportionate to the bulk cocoa market. Reasons for this can be attributed to the fact that the countries producing fine or flavour cocoa, for the most part, are located in tropical America. These countries have had difficulties in attempting to expand their cultivation areas. They also lack permanent and adequate improvement programmes to address some of their serious genetic and production problems. Perhaps the most important among these problems are diseases, particularly Ceratocystis wilt, caused by the *Ceratocystis fimbriata* fungus. Another problem is the low yield of cultivars in current use, due in part to poor agronomic practices on plantations (Enríquez, 1982; 1985).

Ecuador is the largest fine or flavour cocoa producer in the world. Over the past decade it has neglected the quality and physical cleanliness of the beans and it is very probable, if this state of affairs does not change, that it will continue to lose its standing as a fine or flavour cocoa producing country. Currently 50% of its production is graded as bulk cocoa, due to several factors. These include a) lack of control for the physical quality of the beans, because of the absence of strong and enforceable legislation. b) An increase in the number of both, low-quality cultivars, and material with genetic origins different to that of the "Nacional" type. This makes it impossible for the country to be categorised as an exclusive "arriba" flavour cocoa producer. c) The low yield of the Criollo and Nacional type material, and a sombre future outlook due to the lack of adequate genetic improvement programmes. Other important factors responsible for damage to Ecuador's reputation as an exclusive fine or flavour cocoa producer include, a) the exporters, who are not interested in the quality of their exported materials and the processing plants who for sometime, have not been demanding quality or cleanliness. b) The farmers, who claim that they are not paid a high enough premium for good on-farm processing (fermentation and drying) of cocoa beans. As such the standards during fermentation, drying and cleaning of the beans are lower than they were when Ecuadorian cocoa was among the best handled in the world. c) Lack of adequate research and extension the introduction of witches' broom disease recently generated a very violent change in cocoa productivity, and the production of the region as a whole, changed from being one of the highest to lower than that of many other places.

Another important factor affecting the demand for cocoa has been the use of butter fat substitutes. However, since the demand is mainly for the butterfat from bulk cocoa in chocolates, which contain larger amounts (more than 55%) than fine or flavour cocoa types (typically 30 to 35%), the fine or flavour cocoa markets are the least affected. Cocoa butterfat substitutes are other oils found in the tropics, such as that of the oil palm (*Eleais guineensis*), whose cultivation and marketing are more economical than cocoa. Furthermore, laws on substitutes in several countries (England, Denmark, Ireland, among others), allow for a very low substitution percentage, approximately 5%. Attempts have also been made to produce fat through biotechnical means, cultivating cells from the cotyledons, but the cost is currently very high, and the quality of fat obtained does not compete with that of natural cocoa.

Another factor which may affect the demand for cocoa is the replacement of chocolate in the manufacturing plants with "filled" products such as various nuts, rice, caramel candy, flavours, etc., which have a slight influence on the volumes of chocolate used, but again this is of greater importance in the case of the bulk cocoa than in the case of fine or flavour cocoa.

The concept of fine or flavour cocoa has changed gradually, and remained mainly as the concept of a fine or flavour cocoa for mixtures or as a complement in the manufacture of quality chocolate, together with other types of cocoa sold everywhere in the world and which are known as bulk cocoa (Wood and Lass, 1985).

Other very strong competitors in the consumption of fine or flavour cocoa are coffee and tea as beverages. A major difference is that chocolate bars or liquid chocolate (consumed in most countries that produce fine or flavour cocoa) are high-value energy providers, which can hardly be replaced by tea or coffee. The latter are drunk by custom, but not for nourishment as is the case of chocolate.

Since chocolate consumption increased considerable because of the fall of prices in the world markets (Instituto de Estrategias Agropecuarios (IDEA), 1989), some countries that traditionally did not consume chocolate, such as Japan and China, started to manufacture it. If the average consumption of each Chinese increased by just a few grams, and they were to acquire the habit of consuming high-quality chocolate, the production of fine or flavour cocoa could not meet the demand even if production were to rise several fold.

Classification of quality

The final quality and type of chocolate manufactured is influenced by the type and quality of cocoa that was used to make it. Apart from the inherent genotype used (fine or flavour or bulk), post-harvest processing and the transport and storage conditions can

Genetic material for the plantation

The material to be planted must be carefully selected, since the future of the plantation depends on this. Ideally, the cost of this material should be so low that it is of little importance to the producers. What is important is to select genetic material consistent with the findings of local research, and to ensure that such material meets the requirements of the market, and consequently, those of consumers.

In general, fine or flavour cocoa types produce low yields and are very vulnerable to diseases, Criollo types being the most vulnerable. When Criollo genotypes were crossed with Forastero genotypes to obtain the Trinitario types, these were better producers and less susceptible to diseases (the cases of Trinidad, Ecuador, Venezuela, Colombia, etc), and most farmers tended to plant these varieties, without realising that by so doing they were no longer producing traditional cocoa. They could therefore find themselves producing cocoa of different quality that would have to compete with other countries and be subject to world market restrictions. A typical case is Ecuador, where the pure "Nacional" cocoa type has tended to disappear on account of its high susceptibility both to witches' broom (*C. perniciosa*) and Monilia pod rot (*M. roreri*) (Wood and Lass, 1985; Harrison *et al.*, 1988). More genetic improvement work aimed at better local adaptability is required for this type of genetic material, since projects initiated in several places (Ecuador, Costa Rica, Colombia, Venezuela, Mexico, etc.) have been discontinued. Initial work has thus been wasted, and material in many cases has been lost due to lack of continuity in evaluating it or, in some cases, lack of interest.

Progeny from crosses among the best Criollo types of the Turrialba collection in Costa Rica were planted, but they are not being evaluated, for reasons that cannot be fully understood. The situation is similar in Ecuador, where a large number of "Nacional" cocoa selections and crosses are being maintained without being adequately evaluated. Furthermore there are no genetic improvement programmes for this material.

Historically, much of the progress made towards the improvement of fine or flavour cocoa cultivars is based on those collections found throughout the world which have been documented and well maintained (Enríquez, 1989; Clapperton, 1994). However, some of these collections, such as those in Ecuador and Costa Rica, have experienced great changes, the latter even being in danger of extinction.

Management practices

The adequate management of the plantation seems to have little influence on the intrinsic quality of cocoa, but it does affect its physical quality (Wintgens, 1992). Nevertheless, we must introduce good management practices into the plantation to ensure better yields, to benefit the producers and to provide encouragement to continue with efficient production.

In Malaysia, where genotypes produce slightly acid cocoa pods, it is recommended that the pods be placed in heaps for 7 to 10 days to reduce the effect of acidity. During this time the pods can lose up to 40% of their sugars and 50% of their pulp volume, which considerably improves the quality of the beans at the end of fermentation.

Opening

Opening the pods can have important effects on the final quality of cocoa. a) If the pods are opened with a knife or a "machete" it is important to take care not to injure the beans, since this affects the fermentation process by changing the rate of permeability. This is important especially in the early penetration of sugary substances, thus changing the flavour of the bean. b) When the pods are cut open, fragments of the shell may fall into the fermenting material, and substances in the shell which prevent bean germination can negatively affect fermentation of the beans. Also, after drying, these fragments affect the cleanliness of the beans. If pods are opened using machines such as are being used in several countries, it is necessary to have a specialised team or workers removing fragments, or special devices in the cracking machines to eliminate shell particles. These pieces of shell may be difficult to see, even when they are transported on small conveyor belts.

The place where the pods are cut open is also important, since the mass to be fermented must not be contaminated with dust, grass particles or materials used in transportation.

Fermentation

This is perhaps the most important step, but that to which the least importance is attributed by small and medium-scale farmers. A great number of methods to ferment small and large quantities of cocoa have been described (Rohan, 1960; Enríquez, 1985; Wood and Lass, 1985; Enríquez, 1990a) with the intention of ensuring the best possible fermentation. The adoption of a standard method is important because homogeneity of the cocoa guarantees and ensures its sale. Whatever the method is, it must be applied in the best possible manner (López, 1987). It is also important to maintain clean containers, remove the beans regularly and in due time, cover the beans being fermented to maintain a constant temperature, and ensure good aeration but avoiding winds that will cool the beans (Enríquez, 1995).

There will always be different fermentation methods for different regions, genotypes or situations. Each farmer must, therefore learn the most appropriate method for their particular situation, and apply it permanently to maintain the quality of the product (Enríquez, 1990b). The altitude of the place where the fermentation takes place is also important, because this affects the temperature of the environment (Enríquez, *et al.*, 1990).

The duration of fermentation is the single most important factor affecting the fermentation process, that is, the time elapsed from placing the beans in the fermentation container to the time they are withdrawn from it. This varies greatly from one genetic can be easily contaminated by odours, and this would damage both the flavour and the aroma.

In the case of both natural and artificial drying, as has been mentioned, it is necessary to control the temperature and to continuously mix the beans adequately. If this is done sufficiently, it can function as a polishing operation at the same time. When the drying is done in machines with unpleasant-smelling fuels, great care must be taken to avoid contamination, by diverting the fumes or bad odours and preventing their contact with the material being dried. One good solution to the drying problem could be a combination of sun drying in the beginning and artificial drying later, to extract moisture in the final stage, and leave the beans with a water content of 6% to 7%, which is ideal for handling and transportation.

Polishing

Polishing of the cocoa beans is a tradition of the old cocoa farmers of Ecuador, Grenada, Colombia, Brazil, and some other cocoa producing countries. The most important purpose of this practice is to make the beans colourful and shiny. This is done by removing all the mucilage left after fermenting. If this is not done with special care, many beans could be broken, adversely affecting quality (Enríquez, 1989).

When the number of beans to be polished is small, as in the case of the small producers, the work is difficult and they must use methods, such as washing, to get clean and shiny beans. This process may seem detrimental to the farmers, since the weight diminishes considerably depending on how much the beans are polished. Furthermore, farmers must invest additional wages for each fermentation. Polishing does not result in an improvement of the chocolate flavour or the intrinsic quality and is exclusively an appearance factor that can generate prestige in terms of trade, not flavour.

Some farmers even wash the cocoa without fermenting it and then dry it. This is detrimental since flavour is not developed. It is not good for the manufacture of premium chocolate, but it has a very pleasant appearance; it is attractive for traders, but undesirable for the manufacturers.

Storage and transportation

During storage and transportation, the beans must be properly insulated to avoid contamination by odours and infestation from outside sources.

Temperature and humidity, are two important factors to consider during storage. Several studies have been conducted on their effects, and the optimum temperature and humidity conditions for storage and transportation are known (Enríquez, 1985; Wood and Lass, 1985). Transportation can be considered to be storage in movement. The smaller the quantities of cocoa, the more difficult the storage; this is why small producers must sell their product as soon as it has been dried to its optimal level.

4. Due to neglect in the management of the crop, some countries are losing their standing as producers of fine or flavour cocoa, such as Ecuador, the largest producer of this type of cocoa.
5. The consumption of chocolate and some cocoa by-products is continuously increasing, especially when there is overproduction and the prices fall.
6. Commercially, cocoa is divided into three categories; fine or flavour (Criollo), bulk (Forastero), and a broad, good quality mixture (Trinitario).
7. To ensure the best quality of cocoa it is necessary that all the steps of the production, not only the fermentation process, be handled with a high standard.
8. There is an urgent need to create and maintain genetic improvement programmes for fine or flavour cocoa with continuity. Some of the unfinished work can be rescued.
9. Knowledge of each farmer's genetic material is very important in order to adequately regulate the fermentation time, and to appropriately handle the entire processing operation.
10. Criollo type cocoa is easy to ferment (from 15 hours to 3 days); the Forastero type is more difficult to ferment (up to 12 days).
11. Organic cocoa is taking over one part of the world market, although its marketing has some difficulties.

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(resources permitting) but at the same time each day from the same point(s) in the sweatbox. The thermometer probe should be long enough to reach close to the centre of the mass of beans. The end of fermentation can be judged by the cut test, pH and temperature measurements. Different accessions may have differing fermentation times according to genotype and seasonal influences i.e. amount of mucilage or pulp.

After fermentation, the samples should be removed from the sacks being careful not to mix up any of the labels. The beans should be heaped up in wooden drying trays, partitioned to keep each sample separate and placed in the sun to begin drying. Drying must be gradual with constant turning to ensure uniformity in the drying process. Dry only for a few hours a day initially and once the moisture content reaches approximately 20% drying can be for a longer period each day. Usually, weather permitting, drying should take about 4-5 days to reach final moisture content of about 7.5%.

After drying, beans would usually be stored in quarter size jute sacks, similar to the ones used in shipping actual beans. However to avoid problems with moths, mould and other infestations we have recently adopted the use of plastic food grade containers. These were adapted by cutting a 2-inch diameter hole in the lid and covering it with fine mosquito netting to allow any volatiles to escape and to prevent condensation on the sample. Dried beans should be stored in a cool dry area secured from any insect and animal pests. Care should be taken to prevent damp conditions that may favour mould growth and allow re-absorption of moisture in the samples. Storage should be for at least 12 weeks for the sample to equilibrate (this also mimics average time of shipping from drying to delivery at a chocolate manufacturer).

Secondary processing involves roasting, breaking and winnowing, grinding and milling. Roasting should be done on a coned and quartered sample of beans from the particular accession. A batch consists of 330 g of beans weighed out and placed in suitable wire or stainless steel tray one bean layer thick. This is roasted in a mechanical convection oven set at 145ºC for 30 minutes and after roasting allowed to cool.

Once the beans have cooled, pass them through a cocoa breaker (such as the John Gordon Limpritador) twice: once at a coarse setting and again at a fine setting. Next, transfer the sample to a cocoa winnower (such as the John Gordon Catador). Gradually feed the broken nibs and shell into the hopper, being careful not to overload the winnower. It is best to re-run the nibs through the winnower to ensure that all shell pieces are removed. Following this the nibs should be visually inspected, removing any stray pieces of shell with tweezers. Clean the breaker and winnower between each sample to prevent cross contamination.

Store the nibs in food grade plastic containers with tight fitting lids. Use a medium to heavy-duty coffee mill to break the nibs up further, being careful not to over load it. The nibs should be coarsely ground in twelve 1-second pulses of the mill to prevent too much heat from affecting the sample. Continue until all the nibs for that particular accession have been ground, then transfer the ground nibs into food grade plastic containers with

Strategy for the Organoleptic Assessment

D.A. Sukha

Cocoa Research Unit

Briefly defined, sensory evaluation/analysis or organoleptic assessment is a multidisciplinary science that uses human panellists and their senses of sight, smell, taste, touch and hearing to measure the sensory characteristics and acceptability of food products. Sensory evaluation should not be a set of methods but rather a set of design strategies and skills so that appropriate techniques can be devised for each task.

Sensory analysis is applicable to a variety of areas such as:

- product development,
- product improvement ,
- quality control,
- correlation between sensory and chemical/physical properties,
- storage studies,
- applications in cosmetics, perfumes, tobacco products, animal foods etc. and
- process development.

Any discussion on sensory evaluation must deal with taste perception and the organs of taste. Essentially, taste is the sensation on the tongue whilst flavour is the sensation produced by a material taken in the mouth. The tongue is the primary organ dealing with taste perception. This is achieved by using the sensory receptors of the taste buds to transform the chemico-physical stimulus of food to neural signals. There are many theories about how we taste but these are outside the context of this presentation.

Sensory panels

The primary mode of sensory assessment is the sensory panel. It must be treated as a scientific instrument if it is to produce reliable, valid results. Tests using sensory panels must be conducted under controlled conditions using appropriate experimental designs, test methods and statistical analyses. Only in this way can sensory analysis produce consistent and reproducible data.

The main objectives of sensory evaluation under the purview of this project will be: to conduct training in the sensory evaluation of cocoa liquor and the evaluation of cocoa liquors via profiling, descriptive and differentiation techniques.

Sensory evaluation is often considered to be very subjective in nature. However, proper standardised training, sample preparation, evaluation methods and data analysis should aim to offset the subjective nature of sensory evaluation and allow for active collaboration and exchange of information between panels using similar methodology.

would be comprised mainly of spit cups, rinse cups, napkins, data sheets, pens, pencils, crackers and treats.

The room selected for evaluations must be clean and free of distractions. The vessels used for sensory must be either white or clear and free from any sample residue.

Liquors must be thawed gradually in a water bath to avoid excessive condensation. Thawing at a temperature not exceeding 55ºC avoids volatilisation of flavour components in liquors. Liquors are usually served at 40 – 45ºC and stirred thoroughly before serving to correct any fat separation that may have occurred during thawing.

Panellist training

After initial panellist pre-screening, the purpose of panellist training is to select from the available population those individuals who are suitable for further training. Panellist training follows a series of progressive steps that are outlined below.

The vocabulary used in sensory evaluation is very specific and certain words are used to describe very precise flavour attributes and these eventually become associated with the taste. For example: "hammy" is self-explanatory and is easy to remember and associate the word with the taste.

Panels must therefore all speak the same sensory language. For this we have a sensory glossary for cocoa liquor as a guide to prevent "new" and "unfamiliar" associations from developing out of control. However at the same time, panellists must be free to express any truly new and potentially valuable taste sensation, hence a comment section is included in the sensory evaluation forms.

The steps in sensory evaluation are as follows:

1. Initial panellist screening and selection based on a questionnaire form.
2. Evaluation of basic tastes to determine if a person can identify the basic tastes in solution as well some cocoa related tastes in solution.
3. Evaluation of threshold concentration to determine the threshold concentration at which each panellist can identify the basic tastes in solution. A panellist's sensitivity to each taste attribute is assessed here.
4. Introduction of cocoa liquor flavour attributes. The range of flavour attributes present in cocoa liquors are introduced to panellists viz. cocoa flavour, fruitiness, floral, acidity and astringency. For each attribute, the panellists generate vocabulary and a standardised vocabulary is introduced. The glossary of flavour terms is also introduced here.
5. The range of off-flavours and other flavour attributes that can be present in cocoa liquors are introduced to panellists e.g. smokiness and raw/beany.
6. The scoring and ranking of each flavour attribute is done by panellists using different sensory tests *viz.* triangle tests, paired comparison tests etc. Vary the concentrations of the main flavour attributes present in the liquor by mixing with other liquors.

Scaling of extreme scores by ratios using hidden references is another technique to address inconsistencies within panels. Hidden references of known flavour attributes are included to check the degree of confidence in panellists' scores. These checks could be used to adjust the scores of panellists who show different sensitivity to particular attributes compared to the rest of the panel. Their scores for the test sample can be adjusted using the ratio of their score for the hidden standard to that expected. Alternatively, coded reference liquors can be used to indicate the degree of confidence in an individual for a particular flavour attribute. Scores with low confidence could reasonably be given low weighting in calculating means or can even be ignored.

In conclusion, attempts to improve consistency under the purview of the project through training exercises must bear the following considerations in mind. Reference liquors for training should come from one place and the same person in one location should do training of panel leaders for the different countries.

G. Enríquez
This needs to be discussed.

E. Cros
This is a global experiment.

G. Enríquez
This should be addressed later.

E. Cros
Do we want criteria to differentiate bulk and fine or flavour cocoa or do we want to establish criteria for all types?

G. Enríquez
We first need to define cocoas.

D. Sukha
Marketing definition for fine or flavour cocoas actually represents a mixture of genotypes from a particular country. Samples should be taken from areas that have fine or flavour types and take a standard genotype e.g. ICS 1 for Trinidad. Take samples from parental types and the mixture that is exported.

E. Seguine
I am very interested in the project but I have a problem from the manufacturing point of view. In Ecuador you have Arriba cocoas which are sold in grades which have nothing to do with flavour. In Ecuador CCN 51 is being planted extensively which is nothing like the original Nacional. Manufacturers won't pay a premium for Arriba cocoas because this CCN 51 has a poor flavour.

You all are looking for a method by which the flavour types that can be sold separately from the bulk types. CCN 51 is derived from ICS 95 × IMC 67. One tree was selected and crossed to an oriente (from the Andean slopes). IMC 67 is from the Amazon region. That's why CCN 51 has no flavour. It has a lot of cocoa butter from IMC 67. Some farmers took the liberty to call CCN 51 "Nacional" but it is not. In reality, CCN 51 is a good economic bean that processes very easily.

D. Butler
Each participating country should select some types that are representative of their fine or flavour types. Like ICS 1 in Trinidad, Nacional types from Ecuador and Porcelana from Venezuela. Each country should select reference types for fine or flavour. Then compare this with a commercial samples to determine how much mixing is happening. Sampling must be kept simple to avoid too much work, both for fine or flavour and bulk cocoas.

E. Cros
Pod storage is more important in affecting flavour than season.

G. Enríquez
Five trees from each clone, hand pollinated under optimal growing conditions can yield 25 pods from each tree. We need at least 5 trees from the same clone.

E. Cros
Chemical analysis/composition is affected by the pollen donor. You may need to test maternal and paternal effects.

G. Enríquez
From a genetic point of view, self-pollinated types lead to inbreeding depression i.e. small flat seeds, small pods and sterility. In Ecuador they tried selfing and by the third generation it all disappeared. ICS 1 might not be a good standard as it is highly susceptible to Ceratocystis in Ecuador. But if ICS 1 exists in other countries then they should use this. I suggest that the pollinator be the same type. But I don't know if there is a substantial effect since I never looked at it.

D. Sukha
If we use open pollinated pods is this a waste of time?

E. Cros
Yes, it would be too long and too complicated.

L. Johnson
What is the range of the pollinator?

G. Enríquez
With a little wind it can travel very far. So I do not recommend using open pollinated pods. Pollen has an effect on seed colour as seen by crossing SCA 6 × CATONGO but the effect on flavour is not known.

Sensory Assessment

D. Sukha
It is suggested that we send the range of samples fermented at different times to a number of manufacturers for sensory assessment and get a feedback to get a consensus. Why not send all samples to 1 or 2 manufacturers?

E. Seguine
Be careful to whom you send samples since they would be biased to what they produce. Ask a big company to carry out the test because they have a big sensory panel. Do not ask them what it is good for, use small manufacturers for this question.

Strategy for Chemical Assessment of Quality Parameters

E. Cros

Centre de Coopération Internationale en Recherche Agronomique pour le Développement Centre - Culture Pérennes

Transcript of Presentation

Summary

An informative account was given of the biochemical compounds and their changes during processing of fine or flavour cocoa which influence flavour. The influence of genotype is accepted as a contributing factor in a complex of parameters, which affects flavour. The combined effects of genotype and post-harvest processing are deemed critical with roasting perceived as the final touch in flavour development.

The presentation was structured in five parts:

1. Secondary metabolic compounds as markers for differentiation of bulk and fine or flavour cocoa.
2. Possible influences of different treatments.
3. Chemical compounds/contents - what do they mean or do?
4. Methods to differentiate between varieties.
5. Proposed strategy.

A listing of secondary metabolites was presented together with their distribution within the plant kingdom. The question as to whether secondary compounds are due to differentiation of the plant kingdom was suggested to be important to keep in mind. The relationship between chemical compounds and flavour in cocoa was elaborated.

Bitterness is due to the combined effect of purines, peptides, polyphenols, Maillard compounds and diketopyperazine. Astringency is attribute to solely polyphenol content whilst acidity depends on two short chain acids: acetic and lactic acids. Aroma is due to the presence of volatiles.

During the course of cocoa fermentation, aroma increases and this is associated with a decrease in both bitterness and, especially, astringency. The acidity profile was shown to increase and then decrease during the course of fermentation. The fermentation of Porcelana from Venezuela was used as an example: 2 types of boxes, 2 pod opening delays (0 or 5 days), 2 mixing times (12 or 24 hrs) and then oven dried. These factors each influenced more than one flavour attribute but more importantly there was a significant interaction between factors, the effect of which was not additive. The effects of fermentation are dependent on the condition of fermentation but the importance of caution was stressed when claiming the general applicability of these results.

In response to a question on long-term storage of cocoa beans, it was pointed out that dry storage affects many changes, not the least of which is a decrease in the level of reducing sugars. The complexity of flavour was stressed and the importance of post-harvest processing was again emphasised with fermentation being recognised as a key factor of quality.

A list of "chemical attributes important to flavour" was put forward. Apart from physical attributes such as cut test scores, bean size, bean weight, important chemical attributes included:

a) acidity
b) ammonia
c) cocoa butter (content & hardness)
d) aroma precursor contents
e) polyphenols
f) purine content
g) volatiles

The hardness of cocoa butter was deemed as irrelevant since cocoa butter was added to all samples of cocoa during manufacturing. Aroma precursor contents depended on the degree of fermentation. The ratio of fructose to glucose and the ratio between hydrophobic and hydrophilic free amino acids are thought to be interesting. Polyphenol content is a genotypic effect, which is affected by the degree of fermentation, but the analysis is only really applicable to raw beans. The ratio of theobromine to caffeine was suggested to be of potential value for separating cocoa varieties. Overall varieties could be separated on the basis of polyphenol content, the ratio of hydrophobic amino acids to hydrophilic amino acids and the ratio of theobromine to caffeine. For the analysis of volatile compounds it is essential to use fresh beans, where there might be 50-60 compounds. However the results would only be relevant for the comparison of dry bean samples if they were processed in the same way. PCA analysis could then be used to discriminate between different origins.

In conclusion, the value of chemical analysis was emphasised from a scientific point of view, as a method of characterising or controlling a product and it permits variation to be segregated, but it is expensive and time consuming. Recent methods to differentiate between closely related samples - NIR spectroscopy and artificial nose have been postulated as alternative approaches, but both need a robust database. However, the sensitivity of these techniques is exceptional and, in the case of grapes, can distinguish between different locations on the same hill for the same grapevine varieties. The strategy for chemical assessment is visualised as a means to accrue basic knowledge (with analyses on fresh beans and fermented and dried beans) and for differentiation, results from samples with different treatments must be accumulated to examine these effects.

E. Cros
Chemical analysis has no value without replicates. There is a need to repeat fermentations.

E. Seguine
Fermentation a week later would use pods that have temporarily undergone the same climatic maturation.

R. Van Loo
Differences are to be expected between 2 boxes and 2 bags within the same box.

B. Lauckner
The project must take seasonal effects into account for interactions with time.

E. Cros
The effect of time is well known.

D. Sukha
Mucilage content also changes during the season.

R. Van Loo
Perhaps we should split the discussion into two areas: which chemical traits to measure and experimental design.

S. Espin
There is a list of methods already in use in Ecuador.

J.M. Anga
A clear procedure is needed. First define a compound, then decide on a method. (The list of "chemical compounds" from E. Cros' presentation was displayed and discussed in turn to determine relevance to the project). Let us agree to take first 4 components and we will discuss the others. We will return to Susanna Espin's methods later.

D. Sukha
Why not analyse hardness of cocoa butter?

E. Seguine
All bulk cocoas have significantly more cocoa butter. Some cocoa beans will not be extracted for cocoa butter.

G. Enríquez
The project is to distinguish genotypes not only for flavour.

E. Cros
These are the two sides to the project.

J.M. Anga
Only when we know if the compounds are not important.

S. Espin
Pyrazines were suggested by PNG based on results that indicated that these compounds have potential to differentiate between local types of cocoa.

E. Cros
I suggest that the fructose/glucose ratio is important for differentiating genotypes.

G. Enríquez
Let us follow the proposal.

J.M. Anga
Look at the section dealing with chemical compounds; the first activity is fermentation index.

E. Cros
This is useful only for Forastero cocoa.

J.M. Anga
The second activity is physical acidity and titratable acidity and the third activity deals with volatile and non-volatile acids.

E. Cros
What is the need for volatile acids? To control fermentation?

S. Espin
We are worried about the need to find a methodology to discriminate between bulk and fine or flavour cocoa.

J.M. Anga
What about the HPLC?

S. Espin
HPLC is good but we need a methodology for both volatile and non-volatile acids

D. Sukha
The standards for volatile and non-volatiles are different.

S. Espin
I have a proposed methodology.

J.M. Anga
Is the choice of methods the issue here?

D. Butler
A few years ago we had project on butterfat content and the results showed grouping between types; some populations being different from others.

B. Lauckner
Having agreed to measure this variable, then we need an accurate and reliable way to obtain unbiased readings.

J.M. Anga
Polyphenols, tannin and theobromine.

D. Sukha
Is the colour of raw and fermented beans acceptable?

E. Seguine
Bean nib colour and colour of liquor are important.

F. Brito
Volatile compounds are helpful to discriminate genotypes but we need fresh beans and therefore on-site GCMS.

E. Cros
Is anthocyanin important?

E. Seguine
Yes for Forastero versus Criollo.

S. Espin
Polyphenols are a large diverse group. Which ones should be studied to differentiate?

E. Cros
The only difference in polyphenols can be found on fresh bean.

F. Brito
Polyphenols are also a good index of fermentation.

E. Seguine
I'm confused. A lot of discussion has taken place. Raw cocoa comes up. Emile has particular interests but the objective of project is clearly not on raw cocoa. Until cocoa is roasted you have no flavours of value. Many countries have different sources of fine or flavour cocoa so that during fermentation their fine or flavour characteristics can be best expressed.
G. Enríquez
Some countries can address specific problems if they want to.

DNA Profiling and Spectral Imaging Analysis

R. Van Loo

Plant Research International BV

Transcript of presentation

Summary

An overview for non-specialists of the method of DNA profiling (microsatellite analysis) and the principles behind this method was given. The sequence for DNA fingerprinting was outlined and tentative estimates were presented of the number of microsatellite primers (10) needed to distinguish genotypes of fine or flavour and bulk cocoa. A clear, simplified overview of spectral imaging was also presented and the need for sufficient samples to create a sample database was raised. The type of these samples (genotypes and fermentation method) must be determined as well as the number of samples. A figure of 200 was suggested but ensuing discussions pointed to a reduction in this figure.

DNA Profiling

For DNA profiling of cultivars, microsatellite analysis will be used. Microsatellites are already documented in the literature, and the development of new microsatellites could be undertaken if necessary. Testing can be done on cultivars and at different stages of processing. The reasons for using microsatellites were given as:

- They are reliable and fast.
- They work with different types of plant material.
- They are easy to do.
- They are polymorphic and multi-allelic.
- They can be automated.

The principles of microsatellite amplification and information obtainable from band profiles were presented. The position and intensity of bands can distinguish cultivars and separate homozygous and heterozygous material. The sequence for DNA fingerprinting was outlined viz:

- Isolate high quality genomic DNA from young leaves; lyophilise plant material, 1 bulk and 1 fine or favour sample.
- Enrich for microsatellite containing DNA fragments.
- Amplify and clone.
- Identify and sequence.
- Test for reliability and polymorphism.
- Test DNA isolation procedures on 5 fine or flavour, and 5 bulk samples.
- Use 10 microsatellites for fingerprinting 20 bulk and 20 fine or flavour samples.
- Possible uses of DNA marker technology are seen as
- Identification of good and bad quality genotypes.

Discussion on DNA profiling and spectral image analysis

DNA profiling and Spectral Image Analysis

O. Sounigo
Microsatellite work on beans and chocolate has already been done at Nestlé and CIRAD. How many microsatellites markers will be used?

R. Van Loo
Ten microsatellites to start with. These will be tested to determine if they reveal enough alleles on 20 varieties. If they are insufficient then we will develop more, otherwise trinucleotide repeats will be undertaken.

E. Cros
The same clone from different countries will produce different cocoa due to environmental conditions and post-harvesting processing. How do you decide if this DNA gives bulk or fine quality?

R. Van Loo
I agree, but I also think in this project it was assumed that genotype has an influenced on whether or not a fine or flavour and bulk cocoa can be produced, although environmental effects on cocoa quality exist.

E. Cros
Is DNA linked to quality?

R. Van Loo
We have to find out.

E. Cros
There could be various interpretations of results depending on geographic location?

R. Van Loo
Yes, but results in a particular country are still valid. The predictive nature of the tool is influenced by the genotype × environment interaction. The existence of genotype × environment effects within a country would lead to loss of the predictive value of this method.

G. Enríquez
We have to be careful handling beans. Can we start by using leaf material?

R. Van Loo
We shall start with leaves then we'll test beans.

Collaboration between the Manufacturing Industry and Research Participants

P. Manickchand

Produce Marketing Associates

A brief description of the major activities of a cocoa farmer was presented, making it clear that farmers are most concerned with having good genotypes. Most farmers consider that flavour is not a factor that they determine, but the chocolate manufacturers provide information and feedback to the farmer on flavour. The manufacturer also determines the value of the cocoa and whether it is marketable.

There is some doubt whether flavour profiles are of benefit to the farmer, so perhaps farmers should not be involved directly in the project. However, the idea of having certified material would be advantageous since it would increase the probability of market ventures with the manufacturers.

E. Johnson
They have a narrow genetic base.

F. Amores
We need to have additional information to validate the parameters that manufacturers use to assess the farmers' cocoa. This is to improve the fine or flavour cocoa trade. We need to have easy ways to determine the quality of cocoa using dried beans. This information will supplement other information such as those based on liquor.

P. Manickchand
I do not know if it is beneficial to analyse beans before roasting because lactic and acetic acid would still be present and these affect flavour.

E. Seguine
If the flavour potential is not there, no roasting treatment is going to allow the generation of a superior product. It is therefore not so important to focus on individual traits as much as flavour potential. I think that it is useful to know how good a cocoa will be in the final product. It is also useful to detect adulteration.

P. Manickchand
The problem of adulteration does not affect Trinidad, but it does affect Ecuador.

D. Sukha
As a farmer and exporter, what are your problems with marketing beans? What would you like to see happen?

P. Manickchand
I would like to get the best price for the cocoa.

D. Sukha
Have you had problems with buyers complaining about the cocoa sold?

P. Manickchand
Yes, a "smoky" sample complaint was received, but the project details do not affect me.

D. Sukha
Wouldn't you like to know how to differentiate one sample from another?

P. Manickchand
No, it's the buyer who decides whether he likes what we sell.

E. Seguine
There are practical issues such as mix up of beans at the port.

Data analysis and interpretation discussion

Physical parameters to be measured

- Changes in temperature with time
- pH
- Bean weight, shell content
- Cut test

E. Cros
Measuring temperature is not an attribute of cocoa fermenting, but is a treatment that allows the determination of whether fermentations are ideal or not.

G. Enríquez
Use of Rohan method resulted in unsatisfactory results viz. erratic temperature controls and uneven distribution of temperature

Material to be studied

Eight genotypes in each of four countries to be studied including the common genotypes
Size of sample and repetitions needs to be considered

B. Lauckner
To have sufficient degrees of freedom for acceptable statistical interpretation, each treatment should be repeated three times.

V. Mooleedhar
Between and within season variation has to be considered. There maybe fermentation × genotype interaction. A replication of four will be advisable to cater for this.

R. Van Loo
Prefer a 50-50% representation of bulk and fine

D. Butler and N. Hollywood
Problem with finding bulk cocoa

E. Seguine
Ask manufacturers to identify fine and inferior Trinidad cocoas

E. Cros
Use poorly processed samples to represent non-fine cocoa

E. Johnson
Is that bulk?

Recommendations and agreements

Proposed Assessment Strategies

Sampling

10 samples in total from each country, comprised of:

- 2 common clones (1 fine or flavour and 1 Forastero).
- 4 other fine or flavour cocoas.
- 4 fine or flavour samples from different farms &/or inter-country locations (commercial samples).
- A Ghanaian bulk sample as a control supplied from Guittard Chocolate Co.

Common clones agreed after the workshop are as follows:

Fine of flavour clones

- ICS 1 (Ecuador, Papua New Guinea, Trinidad and Venezuela)
- EET 400 (Ecuador, Trinidad and Venezuela)

Bulk clones

- IMC 67 (Ecuador, Trinidad and Venezuela)
- SCA 6 (Papua New Guinea, Trinidad)

Each country has confirmed that they have sufficient trees to ensure sufficient samples can be obtained.

Replication

- At least two replicates per sample within a season.
- If sufficient fruit are available, two replicates should be harvested at one time. Selected trees within each replicate must be chosen at random. If there are only sufficient fruit for one replicate at one time, the second replicate would have to be harvested later in the season. Trees should be selected at random on both occasions. It is therefore possible that the same tree can be sampled more than once in the growing season.

Verification

- DNA from leaf samples.
- Verification of a master tree for each plot to be completed at 1 central location.
- Central Lab for analysis can either be, Plant Research International (Wageningen) or CRU.
- Each country is then responsible for verifying the true identities of the other trees in the plot.
- By preference, DNA should be sent to the central location for master tree verification but leaves can be sent if necessary (by hand rather than by commercial courier).

- Measure the temperature daily in the sample area at a depth of 30 cm in the fermenting mass using a long probe thermometer or thermocouple.
- Cut test is recommended on bean samples during fermentation. A small number of beans (<5) can be sampled.

Drying method

- Dry to a final moisture content of 7 – 8 %.
- Sun dry for 5 days and if not completed within this period, complete drying in a mechanical ventilated oven at less than 40°C.
- Replicates should be harvested and fermented at the same time where possible, to ensure that drying is carried out under the same weather conditions (see Replication, page 74).
- Everyone must record the periods of sun and oven drying.

Chemical Analyses

Final methods will be consolidated and finalised via E-mail.

Fermentation Index

To be done by all countries except those using *Criollo* and *Nacional* material.

Physical Acidity (pH)

To be done during fermentation.

Titratable Acidity

To be done after drying.

Volatile and Non-volatile Acids

To be done according to the method proposed by Dr. Susana Espin (subject to agreement).

Butterfat Content

- Use the NMR method wherever possible.
- Sample calibration is important.
- Use Soxhlet method as a reference with acid digestion of sample first.

Butterfat melting point

To be done with NMR.

Sample Exchange

Cocoa liquor samples of the common clone should be exchanged between all project member countries for comparative analyses.

Data Analysis and Interpretation

- For each method the data should be pooled and analysed in one location.
- Dr. Bruce Lauckner at CARDI has agreed to lend expertise in this area.
- Plant Research International will do PCA and NIR analyses.

Items to Standardise

- Templates for data presentation.
- Labelling and coding of samples.

Session 1

Chairperson G. Ramos
Rapporteur L. Johnson

13.30	General principles for post-harvest processing of cocoa G. Enríquez - INIAP	
13.50	Strategy for post-harvest processing and physical factors D. Sukha - CRU	
14.10	Discussion on post-harvest processing and physical factors	
15.00	*Tea Break*	
15.30	Strategy for organoleptic assessments D. Sukha - CRU	
16.00	Discussion on organoleptic assessments	
17.00	Conclusions and Summaries	

Thursday 1st February 2001

Session 2

Chairperson J.M. Anga
Rapporteur L. Motilal

9.00	Strategy for chemical assessment of quality parameters E. Cros - CIRAD
10.00	Discussion on methodologies for chemical assessment of quality parameters
10.30	*Coffee Break*
11.00	Further discussion on methodologies for chemical assessment of quality parameters
12.00	*Lunch*

11.00	Adoption of standardised working procedures
11.30	Project Reporting and Accounting Guidelines M. Clayton - CFC J.M. Anga - ICCO
12.00	*Lunch*
14.00 – 17.00	Compilation of information for workshop proceedings

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