These results emphasized on the presence of 6 genetics groups that have many of the studied characters indicating that evaluation processes for samples should be continued under various environments and using perecise methods that depend up finger prints and molecular genetics.

Key words: Yemeni coffee, characterization, genetic variation, coffee types grown.

INTRODUCTION

Coffee is an extremely important cash crop worldwide today, with more than 6.5 Millions tons of green beans produced yearly from about 11 millions hectares. In dollar, coffee takes the second rank after oil with a production worth of more than 9000 M US $/ yearly. World production of *Coffea arabica* represents 70% of total coffee production (Charrier and Eskes 1997)

Yemen is considered to be the first country worldwide to domesticate and cultivate coffee. The production of *Coffea arabica* began during the 14th century in the Yemeni highlands and is still going on today. Due to this, farmers have very vast traditional knowledge in coffee cultivation, maintenance of trees and harvesting. It is likely that accumulation of experiences during these centuries of coffee production in the different valleys (sometimes totally isolated from each other), specific varieties of *C. arabica* have been developed, with new interesting characteristics. Centuries after centuries, increasing cultivated areas; the Yemeni farmers have selected a great number of varieties, particularly well adapted to the specific conditions of each valley. This selection leads also to different qualities of coffee. The area under coffee cultivation in Yemen is over 33000 ha; with production over 11000 tons in the year 2001; and contributes nearly US$ 18 millions to the economy annually (Agricultural Statistics Year Book – Yemen 2001)

Coffea arabica L. ($2n = 4x = 44$) is an allotetraploid plant containing two diploid genomes that originated from two different diploid wild ancestors ($2n = 2x = 22$), *C.canephora* and *C.eugenioides* (Lashermes *et al.* 1999). *C.arabica* is characterized by a very low genetic diversity, which is due to its allotetraploid origin, reproductive biology (self-fertile) and evolution (Charrier and Eskes, 1997).

Only few published information on genetic variation of Yemeni coffee is available: Sylvain (1956) describes several types, which resemble the known commercialized varieties or types as Typica, Harar, Bourbon and Irgalem. Some studies cited local names referring to valley or region as local names i.e., Udeyni, Materi, Hamadi, Gaadi, Shoutaeli, Essaii, Tessawi, Katii, Burai, or referring to morphological characters as Dawairi, Toufahi, Shibriqi, and sometimes the names are combined as Ludia compact, Hewle compact.

Therefore, genetic diversity of coffee landraces in Yemen should be studied through collection, identifing and evaluated with respect to morphological, genetic and biochemical characteristics. This study presents the first results of a work done in the Yemeni Genetic Resources Center (YGRC) with the assistance of the French Embassy.

The aims of this research work are (I) to collect, identify and studying the genetic variations of Yemeni coffee landraces (ii) to preserve them in gene bank and *ex-situ* conservation for further characterization (iii) and further use it in plant breeding for genetic improvement.

MATERIALS AND METHODS

Missions:

The survey was held in the main coffee producing areas in Sana'a. Dhamar, Lahj, Al-Mahwit, Hajjah, Alhoudaida, and Sadah provinces during November 2000 to December 2001.

Three forms of Data- Sheetes were used for local landraces of coffee ecotype or varieties characterization and identification (Eskes and Mukred, 1989). Table 1 shows the different variables used in this study.

Data:

All the values, which were either ordinal or nominal ones, have been changed into numerical data so clustering analysis and building of. dendrogramm can be used by the software JMP 4.0. About 13 regions and 33 sites were visited and coffee trees were studied corresponding to 12

COLLECTION, CHARACTERIZATION AND EVALUATION OF YEMENI LANDRACES OF COFFEE (*Coffea arabica* L.)

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ABSTRACT: Yemen was the first country in the world to domesticate and cultivate coffee (*Coffea arabica* L.) and it became the center for diffusion of coffee towards the world.

The Yemeni farmers have selected and created a great number of forms or cultivars, particularly well adapted to the specific conditions of each region. This selection has led also to different qualities of coffee, the names of which are well identified by Suq sellers and by local consumers.

Missions to all the major coffee growing areas in Sana'a, Dhamar, Al-Mahwit, Haja, Alhoudaida, and Saada, were held to collect, study and evaluate local landraces of coffee ecotype or varieties. About 60 samples of coffee seeds were collected. Morphological, visual observations and characterization of coffee trees in farm have been identified in 33 sites. The morphological features are based on coffee description and information given by farmers (i.e. local naming of coffee types, fertilizer usage, production capacity, ...etc)

Based on the information obtained during these missions, genetic variation have been described for the most characters as plant type, plant height, angle and strength of primaries, degree of secondary branching, size and shape of leaves, size and shape of fruits and beans, fruits color, and productivity.

different local names of landraces (given by farmers) (Table 2). Morphological observations have been completed by the in formations given by farmer.

RESULTS AND DISCUSSION

Three different types of coffee production zones can be distinguished in Yemen:

- Coffee trees in Wadi (valleys) bottoms (between 800 and 1400 m height, irrigated by flood diversion during heavy rainy season and underground water during the remaining months of they year);

- Coffee trees in intermediate plains, between (1400 and 2000 m height), recently settled since the introduction of water-pumps exploiting deep underground water, irrigated the whole year;

- Coffee trees on slopes, from 1600 to over 2200 m height, only irrigated by rain.

About 60 samples of coffee seeds were collected, seed were dried and kept in cold room at 4°C. Hundred dried seeds weight and the portion of bulbs to seeds were determined for each sample. 40 beans were planted from each

samples, seeds were pre-soaked in water for 24 hours, then planted in orgainc matter (bithmus) in small pots (12 x 10 x 7 cm) and placed in glass-house with 30°C day and 25°C night and relative air humidity 45-60%. Germination started after 40-50 days. These seedlings will be serving for establishing living gene bank and for further characterization and classification. Until know no research activities or structure for coffee exists in the country; our research program for establishing a gene bank will permit to study, evaluate, characterize, conserve and use Yemeni coffee landraces in breeding for improving genotypes facing biotic and a biotic stresses.

Table 3, show that, within 33 of Data-Sheetes analyzed, 12 coffee trees have conical shape, 12 intermediate and 9 cylindrical shape; growth habit of trees also showed that, most of the samples are open (22), and 6 samples are compact; primaries angle on the main stem also showed that samples represent the three categories and et..., for all characters studied.

As a first result, we can observe that there is a real diversity within the species *Coffea*

arabica in Yemen regarding the fact that some of the characteristics noted (like shape of tree, primaries shape, thickness, angle with main stem, length of internodes), leaf shape (wide and longer, vines, surface), fruit shape (wide and long) were different for those trees growing in the same field under the same conditions. Some traits given by farmers are obvious clearly due to specific genetic reasons like drought resistance or the lost of leaves during winter.

It also seems obvious that, there are some morphological types existing and characterized by just a few specific traits (like Toufahi: from "Toufahi" (apple) because of the shape of the fruit, Dawairi (rounded, because of the shape of the tree) or Udeyni which is known as a long-life landrace.

Many of the morphological characters are affected by environment, but in general there are also great variations in several characters can be distinct types of coffee, which can represent genotypes or populations. These results are in agreement with those obtained by Eskes and Mukred 1989 in Yaffaa areas.

From our survey we observed that in Yaffaa areas and

districts around the genotypes Essaii is the dominate, which have great resemblance with Udeyni in several morphological and production characters, and differed in fruit size, plant vigor. In Al Hyma, and Banimator, Dawairy genotype is the dominant and we can found Udeyni, Gaadi Shibriqi and Burai or Toufahi under little cultivation. In Haraz Toufahi and Gaadi are dominants, and in Bani Ismail area Gaadi or Ismaily is dominant due to its drought tolerance. In Hufash region Dawairi, and Bonan and Toufahi are under cultivation, and Shibriqi is found in the same area. In high mountains areas Toufahi is dominants due to its high level of cold tolerance; in these areas we found that this ecotype is dropping part of his leaves in winter season facing cold or frost damage. A high variation of productivity was observed within the same ecotype and between ecotype, making it necessity to apply individual selection from the best trees for improving the production of coffee.

Whether the global morphological description corresponds or not to the type named by farmers hierarchical clustering (Spark, 1973) analyses showed that the

dendrogram (SPSS, 1995) for all parameters indicated there is 6 groups of clusters of samples or types (Fig1) which suggested 6 different varieties in term of morphological characteristics described in Table (1). This analysis has been processed also to see if there is some consensus between the variety's names given by farmers (Table2) and the morphological descriptions from the fields. Clusters obtained by morphological traits are not similar to those obtained by names given by farmers as showed in the dendrogram. This can be due to the following reasons:

- one name can be applied to different varieties depending on region.

- one ecotype can have several names depending on region.

- names given by farmers can be related to one type of character which is just a small part of those applied for our descriptions.

To test this last hypothesis we chose those descriptors related to the shape of the trees (data not shown), which we suppose to be one of the characteristics important to farmers.

In this new result, the variety "Toufahi" which has got a very special shape of apple grouped. This corresponds to the supposition that names of ecotypes are given regarding just some characteristics of the trees, regardless of the others (which can be very variable), therefore it is possible that a "farmers ecotype" doesn't really reflect a "biological ecotype".

Results obtained by Lashermes *et al.*, (1999) suggested that Amplified Fragment. Length polymorphism (AFLP) may well offer an efficient way of distinguishing and fingerprinting coffee germplasm collections. The large number of bands and the high polymorphism rate among the coffee accessions indicated that AFLP is an extremely efficient technique for DNA marker generation in coffee.

CONCLUSION

In terms of morphological descriptions of the trees in the filed, we can say that there is a real diversity in Yemeni coffee; hierarchical clustering analyses showed by the dendrogram for all parameters that there is 6 groups of clusters of samples or ecotypes of coffee. Primaries angles, internodes length, strength of primaries, shape

of leaves, growth habit are promising charactores for varietal characterization.

The next steps of this study are still descriptions, both morphological and genetic of the different samples. Once this analysis is done we will be able to describe the pattern of genetic diversity of the Yemeni coffee and also to introduce Yemeni ecotypes in coffee improvement programs. Until now we suppose that, investigating the Yemeni landraces of coffee will be very useful for the coffee production in Yemen and other country, in both terms of quality and quantity.

The obtained results are of great attention for the coffee breeder to improve local ecotypes in Yemen to raise seed yield and other economic cerates to coffee, since genetic variability is the 1st step in any breeding program for improving these yield and yield in coffee.

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Table 1: Morphological observations (variables) used for descriptions and the proposed value of each character.

No	Variable	Values
1	*Shape of tree* (ShT)	Conical 1, intermediate 2, cylindrical 3.
2	*Growth habit* (GH)	Open 1, normal 2, compact3
3	*Height* (H)	Small 1, medium 2, tall 3
4	*Number of stems* (NS)	One 1, few 2, many 3
5	*Density of primary branch* (IP)	Low 1, medium 2, high 3
6	*Primaries angles of the 10th node with main stem* (Pan)	Semi erected 1, nearly horizontal 2, horizontal 3
7	*Internodes length of primaries* (InL)	Short 1, medium 2, long 3
8	*Strength of primaries* (SP)	Thin drooping 1, middle 2, thick strong 3
9	*Color of old leaves* (OLC)	Bronze 1, medium 2, green 3
10	*Color of new leaves* (NLC)	Bronze 1, medium 2, green 3
11	*Shape of leaves* (ShL)	Typica 1, intermediate 2, bourbon 3
12	*Leaves size* (LSz)	Small 1, medium 2, large 3
13	*Leaves surface* (LSu)	Flat 1, intermediate 2, undulated 3
14	*Fuits number per axis* (FNA)	Few 1, average 2, many 3
15	*Fruits size* (FSz)	Small 1, medium 2, large 3
16	*Fruits shape* (FSh)	Sharp 1, elongated 2, elliptic 3, round 4
17	*Beans shape* (BSh)	Sharp 1, elongated 2, elliptic 3, round 4
18	*Beans size* (BSz)	Small 1, medium 2, large 3

Table 2: Sample number, Region and local names given by farmers.

Sample Number	Local Name	Region
1	Dawairi Burai	Bura Alhodaidah
2	Toufahi Burai	Bura Alhodaidah
3	Toufahi	Anis Dhamar
4	Dawairi Gaadi	Anis Dhamar
5	Udeyni	Anis Dhamar
6	Udeyni	Anis Bani Fadel Dhamar
7	Dawairi	Wadi Habab Dhamar
8	Dawairi	Al hayma Wadi Almasna'a Sana'a
9	Udeyni	Al hayma Wadi Almasna'a Sana'a
10	Toufahi	Al hayma Wadi Almasna'a Sana'a
11	Udeyni	Al hayma Wadi Almasna'a Sana'a
12	Udeyni	Alrisaa Mafak Al Hayma Sana'a
13	Gaadi	Alrisaa Mafak Al Hayma Sana'a
14	Shibriqi	Al makhbath Bani Matar Sana'a
15	Udeyni compact	Al makhbath Bani Matar Sana'a
16	Udeyni	Al makhbath Bani Matar Sana'a
17	Toufahi	Hofash Al Mahwit
18	Toufahi	Haraz Wadi Lahab Sana'a
19	Gaadi Baid	Haraz Wadi Lahab Sana'a
20	Gaadi Aswad	Haraz Wadi Lahab Sana'a
21	Udeyni	Alyaer Al Hayma Al Dakhlia Sana'a
22	Dawairi	Alyaer Al Hayma Al Dakhlia Sana'a
23	Gaadi Harazi	Alyaer Al Hayma Al Dakhlia Sana'a
24	Shibriqi	Alyaer Al Hayma Al Dakhlia Sana'a
25	Shibriqi	Razih Sadah
26	Udeyni	Razih Sadah
27	Toufahi	Hofash Al Mahwit
28	Burai	Hofash Al Mahwit
29	Dawairi	Haraz Sana'a
30	Dawairi	Madinat Al Shark Dhamar
31	Udeyni	Al Ahgour Al Mahwit
32	Dawairi	Al Ahgour Al Mahwit
33	Toufahi	Al Ahgour Al Mahwit

Table 3: Characters studied and the number of samples belonging to different categories.

| Characters	Categories		
	1	2	3
Shape of tree (ShT)	12	12	9
Growth habit (GH)	22	5	6
Height (H)	8	11	14
Number of stems (NS)	14	8	11
Primaries angles (Pan)	13	12	8
Internodes length (InL)	13	12	8
Strength of primaries (SP)	11	9	13
Shape of leaves (ShL)	12	12	9
Leaves size (LSz)	9	14	10
Leaves surface (LSu)	8	10	15
Fruits number per axil (FNA)	2	12	19
Fruits size (FSz)	9	17	7
Fruits shape (FSh	10	15	8
Beans shape (BSh)	6	16	11
Beans size (BSz)	11	13	9
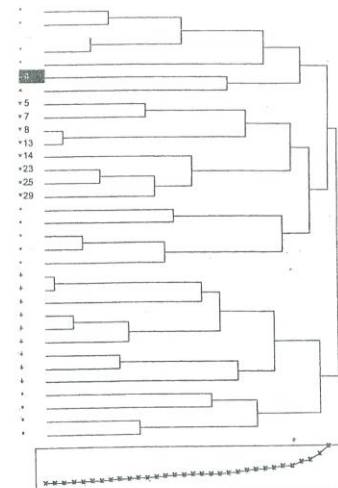
Fig 1: Dendrogram of the landraces, matching morpological descriptions collected in fields.

تجميع وتوصيف وتقييم سلالات محلية من البن اليمنى

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** السفارة الفرنسية باليمن

تعتبر اليمن المنطقة الأولى التى تمت بها زراعة محصول البن ومنها انتشر إلـى العالم، وقد عمل المزارعين اليمنيين على انتخاب طرز وتراكيب وراثية متلائمة مع الظروف البيئية لكل منطقة. كما أدى هذا الانتخاب إلى تميز طرز تتميز نوعيـة مكنـت المنـتج والمستهلك من تحديدها.

هذه الدراسة تهدف إلى التأسيس لمجمع وراثى ومعرفة حجم الاختلافات بـين التراكيب الوراثية والطرز المزروعة باستخدام طريقة التحليل العنقودى بغية الاستفادة منها فى تحسين طرز البن فى اليمن. تمت حملات ونزول ميدانى لجمع معظم عينات البـن مـن المناطق الرئيسية فى زراعة البن والقيام بدراسة توصيفية للأصناف والطـرز المزروعـة وتقييم الاختلافات بين تلك الأشكال المزروعة وفى المناطق المختلفة. أكثر من ٦- عينة تم تجمعها لتشكل نواه وراثى بنك وراثى بغية الاستفادة منها فى برامج التربية والتحسين الوراثى. كما تمت عملية التوصيف على أساس الصفات المظهرية حسب قواعد توصيف البن بالإضافة لمعلومات تم جمعها من المزارعين وذلك فى ٣٣ موقع. أوضحت النتـائج المتحصل عليها وجود اختلافات وراثية لمعظم الصفات المدروسة مثل طول النبات وزاويـة ومسك الفروع الأولية وكثافة التفرعات الثانوية وحجـم وشـكل ولـون الأوراق والثمـار والإنتاجية والتلاؤم مع الظروف البيئية. كما مكنت النتائج من تمييز ستة مجاميع وراثيـة تتميز بالعديد من تلك الصفات مما تؤكد أهمية استمرار عملية التقييم للعينات المجمعة تحت نفس الظروف البيئية والاستعانة بالطرق المعتمدة على البصمة الوراثية والوراثة الجزيئية.

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