African Food Tradition rEvisited by Research
FP7 n°245025

Start date of project: **01/09/2010**
Duration: **45 months**

Deliverable number : Del 4.1.3.1

Title of deliverable: **Report on the quality of the traditional products from *Hibiscus sabdariffa***

Deliverable type (Report, Prototype, Demonstration, Other): Report

Dissemination level (PU, PP, RE, CO)*: CO

Contractual date of delivery:

Actual date of delivery:

Work-package contributing to the deliverable:

Organisation name of lead contractor for this deliverable:

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This document has been send to :

The coordinator by WP Leader	Date: August 2012
To the Commission by the Coordinator	Date:

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1. Introduction

Hibiscus sabdariffa L. is a herbaceous plant, cultivated largely in tropical and subtropical areas of both hemispheres. It belongs to the family of Malvaceae and is known by different names such as Guinea sorrel or bissap in Senegal, karkadé in North Africa, roselle or sorrel in Asia and flora of Jamaica in Central America (Morton & Roselle, 1987; Glew et al., 1997; Lorenzo et al., 2000 ; McClintock.& El Tahir, 2004 ; Babalola et al., 2001 ; Cisse et al., 2009a; Cisse et al., 2009b).

In Senegal, *H. sabdariffa* was introduced in the 19th century (Kerharo & Adam, 1974) and is now grown throughout the territory; mainly in the Kaolack, Fatick Thies, Ziguinchor and Louga regions. In these areas, a dozen varieties are grown including Vimto, Koor, Thai and CLT 92. Traditional processing of the *H. sabdariffa* calyx has been greatly improved by the establishment of many small enterprises. Knowledge of the quality of traditional products is a necessary first step.

2. Sampling

Different samples of bissap products were collected across Senegal (**Figure 1**) according the SOPs for sampling strategy for group 3 (D1.2.1.3). To avoid changing of the sample from collection to analysis, three areas have been selected. This is the region of Dakar where two companies were choosen, the region of Thies at 70 km of Dakar and the region of Kaolack at the center of Senegal at 192 Km at Dakar.

Figure 1. Sampling area of baobab fruit

According the SOPs for sampling strategy for group 3 (D1.2.1.3), the table 1 shows the location of all samples and the number of samples for each area. All the samples are from the specie of *Adansonia digitata*.

Table 1. Location and number of samples of bissap products

	Dakar	Thies	Kaolack
Nectar of bissap	6	3	3
Syrup of bissap	6	3	3

3. Analyses of samples

Samples collected (drink and syrup) were analysed for physical, chemical and textural analysis, microbiological analysis and biochemical and nutritional analysis using respectively SOP's defined on the deliverable D1.2.3.3, D1.2.3.6 and D1.2.3.13.

4. Results and discussion

Table 2 and **3** give the results of the sensory and physical characteristics of bissap products. The four products in each type of product show more or less significant differences.

Table 4 and **5** give the results of the inventory of the technological flora and pathogenic germs of bissap products for different regions. The four products in each type of product are characterized by an excellent microbiological quality. Only yeasts and molds and lactic acid bacteria are present in very limited numbers in some cases. These lactic acid bacteria were not highlighted in the calyx. No pathogen was found regardless of the origin and the type of products.

Table 6 and **7** show the chemical, biochemical and nutritional characteristics for all the products. Total soluble solid is significantly different. This indicates difference on the step of formulation of the products. The four products in each type of product show significant differences. For drink, the product of Dakar 1 presents the most interesting characteristics with titratable acidity, vitamin C content of 59.41 meq.100 g^{-1} and 17.86 mg.100 g^{-1} respectively. The same tendency is observed for the syrups.

In the case of beverage manufactured by the company of Kaolack, a quick comparison shows that in the case of anthocyanins, only 1/9 of the amount initially present in the calyces of *Hibiscus sabdariffa* is found in beverages. The extraction of these compounds is not optimized.

5. Conclusion

The sensory and physical, chemical, biochemical and nutritional characteristics of the products are significantly different. Regarding microbiological analysis, the products have an excellent quality. However, the extraction of the various compounds (anthocyanins, polyphenols, vitamin C, organic acids) is far from complete.

6. References

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Table 2. Results for sensory, physical and textural analysis of bissap drink

Property	Parameter and unit of measurement	SOP number	Respon-sible partner and lab	Bissap drink							
				Dakar 1		Dakar 2		Kaolack		Thies	
				Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)
Physical	Density	Phys-ExtPlantes-01-fr	UCAD @ UCAD	3	$1,05^{c} \pm 0.001$	3	$1,06^{b} \pm 0.002$	3	$1,05^{c} \pm 0.002$	3	$1,30^{a} \pm 0.002$
	Colour parameters (Lab)	Phys-ExtPlantes-03-fr	UCAD @ UCAD								
			L	3	$23,72^{b} \pm 0,37$	3	$24.25^{b} \pm 0,22$	3	$21,93^{b} \pm 0.02$	3	$20.14^{c} \pm 0,25$
			a*	3	$11,88^{a} \pm 0,13$	3	$10.25^{c} \pm 0,15$	3	$11,08^{b} \pm 0.12$	3	$10.12^{c} \pm 0,08$
			b*	3	$1,76^{a} \pm 0,02$	3	$1,45^{c} \pm 0,01$	3	$0,61^{d} \pm 0.11$	3	$1,65^{b} \pm 0,01$

Table 3. Results for sensory, physical and textural analysis of bissap syrup

Property	Parameter and unit of measurement	SOP number	Respon-sible partner and lab	Bissap syrup							
				Dakar 1		Dakar 2		Kaolack		Thies	
				Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)
Physical	Density	Phys-ExtPlantes-01-fr	UCAD @ UCAD	3	$1,30^{d}$ ± 0.001	3	$1,31^{c}$ ± 0.001	3	$1,55^{a}$ ± 0.001	3	$1,32^{b}$ ± 0.001
	Colour parameters (Lab)	Phys-ExtPlantes-03-fr	UCAD @ UCAD								
			L	3	$28,02^{a}$ ± 0.08	3	27.59^{a} ± 0.02	3	$25,63^{c}$ ± 0.94	3	26.59^{b} ± 0.03
			a*	3	$10,70^{b}$ ± 0.05	3	24.29^{a} ± 0.03	3	$19,03^{a}$± 0.04	3	21.77^{a} ± 0.02
			b*	3	$5,31^{d}$ ± 0.04	3	8.62^{a} ± 0.01	3	5.52^{c}± 0.02	3	7.62^{b} ± 0.01

Table 4. Results for inventory of the technological flora and pathogenic germs of bissap drink

Parameter and unit of measurement	SOP number	Respon-sible partner and lab	Bissap drink							
			Dakar 1		Dakar 2		Kaolack		Thies	
			Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)
Enumeration of microorganisms (CFU/g)	Micro-01, ISO 4833	UAC @ UAC	3	$4\ 10^3$	3	35510^3	3	12.10^3	3	150
Enterobacteriaceae	Micro-02, ISO 21528-2	UAC @ UAC	3	0	3	0	3	0	3	0
Escherichia coli	Micro-03, ISO 16649-2	UAC @ UAC	3	0	3	0	3	0	3	0
Bacillus cereus	Micro-04, ISO 7932	UAC @ UAC	3	0	3	0	3	0	3	0
Staphylococcus aureus and CPS	Micro-05, ISO 6888-1	UAC @ UAC	3	0	3	0	3	0	3	0
Listeria monocytogenes	Micro-06, ISO 112901/A12004	UAC @ UAC	3	0	3	0	3	0	3	0
Salmonella	Micro-07, ISO 65792002	UAC @ UAC	3	0	3	0	3	0	3	0
Clostridium perfringens	Micro-08, ISO 7937	UAC @ UAC	3	0	3	0	3	0	3	0
Yeasts and moulds	Micro-09, ISO 7954	UAC @ UAC	3	173	3	2000	3	1200	3	540
Lactic acid bacteria (LAB)	Micro-10, M-METH-MO-13	UAC @ UAC	3	100	3	102	3	150	3	105

Table 5. Results for inventory of the technological flora and pathogenic germs of bissap syrup

Parameter and unit of measurement	SOP number	Respon-sible partner and lab	Bissap syrup							
			Dakar 1		Dakar 2		Kaolack		Thies	
			Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)
Enumeration of microorganisms (CFU/g)	Micro-01, ISO 4833	UAC @ UAC	3	0	3	0	3	0	3	0
Enterobacteriaceae	Micro-02, ISO 21528-2	UAC @ UAC	3	0	3	0	3	0	3	0
Escherichia coli	Micro-03, ISO 16649-2	UAC @ UAC	3	0	3	0	3	0	3	0
Bacillus cereus	Micro-04, ISO 7932	UAC @ UAC	3	0	3	0	3	0	3	0
Staphylococcus aureus and CPS	Micro-05, ISO 6888-1	UAC @ UAC	3	0	3	0	3	0	3	0
Listeria monocytogenes	Micro-06, ISO 112901/A12004	UAC @ UAC	3	0	3	0	3	0	3	0
Salmonella	Micro-07, ISO 65792002	UAC @ UAC	3	0	3	0	3	0	3	0
Clostridium perfringens	Micro-08, ISO 7937	UAC @ UAC	3	0	3	0	3	0	3	0
Yeasts and moulds	Micro-09, ISO 7954	UAC @ UAC	3	0	3	0	3	0	3	30
Lactic acid bacteria (LAB)	Micro-10, M-METH-MO-13	UAC @ UAC	3	0	3	0	3	0	3	10

Table 6. Results for chemical, biochemical and nutritional analysis of Baobab drink

Parameter and unit of measurement	SOP number	Respon-sible partner and lab	Bissap drink							
			Dakar 1		Dakar 2		Kaolack		Thies	
			Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)
pH	Chem-ExtPlantes-01-fr	UCAD @ UCAD	3	$2,39^{b} \pm 0.05$	3	$2,70^{a} \pm 0.03$	3	$2,32^{c} \pm 0.03$	3	$2,44^{b} \pm 0.01$
Total soluble solids (g/100g)	Chem-ExtPlantes 03-fr	UCAD @ UCAD	3	$140,00^{d} \pm 0.36$	3	$224,00^{a} \pm 0.35$	3	$204,00^{b} \pm 0.04$	3	$170,00^{c} \pm 0.06$
Titrable Acidity (meq/100g MS)	Chem-ExtPlantes-02-fr	UCAD @ UCAD	3	$59,41^{a} \pm 0.36$	3	$46,24^{c} \pm 0.35$	3	$33,52^{d} \pm 0.04$	3	$48,94^{b} \pm 0.06$
Total sugar (g/100g MS)	Chem-ExtPlantes-11-fr	UCAD @ UCAD	3	$90,58^{b} \pm 0.31$	3	$25,95^{c} \pm 0.21$	3	$125,36^{a} \pm 4.25$	3	$92,24^{b} \pm 0.59$
Reducing sugar (g/100g MS)	Chem-ExtPlantes-12-fr	UCAD @ UCAD	3	$10,94^{b} \pm 0.34$	3	$10,08^{c} \pm 0.39$	3	$88,45^{a} \pm 0.14$	3	$8,48^{d} \pm 0.53$
Vitamin C (mg/100 g MS)	Nutri-ExtPlantes-01/02-fr	UCAD @ UCAD	3	$17,86^{a} \pm 0.84$	3	$12,50^{c} \pm 1.22$	3	$14,71^{b} \pm 1.10$	3	$14,12^{bc} \pm 0.82$
Total polyphénols g/100g MS)	Bioch-ExtPlantes-05-fr	UCAD @ UCAD	3	$0,32^{c} \pm 0.02$	3	$0,29^{d} \pm 0.002$	3	$0,88^{a} \pm 0.001$	3	$0,46^{b} \pm 0.01$
Total anthocyanins g/100g MS)	Bioch-ExtPlantes-06-fr	UCAD @ UCAD	3	$0,11^{b} \pm 0.00$	3	$0,09^{c} \pm 0.001$	3	$0,05^{d} \pm 0.001$	3	$0,16^{a} \pm 0.001$

Table 7. Results for chemical, biochemical and nutritional analysis of bissap syrup

Parameter and unit of measurement	SOP number	Respon-sible partner and lab	Bissap syrup							
			Dakar 1		Dakar 2		Kaolack		Thies	
			Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)	Number of Samples	(Mean +/- SD)
pH	Chem-ExtPlantes-01-fr	UCAD @ UCAD	3	$2,03^{c} \pm 0.03$	3	$2,45^{a} \pm 0.03$	3	$2,43^{a} \pm 0.06$	3	$2,30^{b} \pm 0.03$
Total soluble solid (g/100g)	Chem-ExtPlantes 03-fr	UCAD @ UCAD		$666,00^{d} \pm 0.02$		$712,00^{c} \pm 0.02$		$775,00^{a} \pm 0.03$		$750,00^{b} \pm 0.03$
Titrable Acidity (meq/100g MS)	Chem-ExtPlantes-02-fr	UCAD @ UCAD	3	$44,45^{b} \pm 0.29$	3	$43,53^{b} \pm 1.38$	3	$13,10^{c} \pm 0.06$	3	$55,92^{a} \pm 0.07$
Total sugar (g/100g MS)	Chem-ExtPlantes-11-fr	UCAD @ UCAD	3	$64,53^{c} \pm 1.34$	3	$71,11^{a} \pm 1.19$	3	$67,07^{b} \pm 0.06$	3!	$61,72^{d} \pm 0.24$
Reducing sugar (g/100g MS)	Chem-ExtPlantes-12-fr	UCAD @ UCAD	3	$20,76^{a} \pm 1.84$	3	$20,22^{a} \pm 1.35$	3	$20,07^{a} \pm 0.01$	3	$14,17^{b} \pm 0.17$
Vitamin C (mg/100 g MS)	Nutri-ExtPlantes-01/02-fr	UCAD @ UCAD	3	$2,25^{a} \pm 0.001$	3	$1,69^{c} \pm 0.001$	3	$1,03^{d} \pm 0.001$	3	$1,87^{b} \pm 0.001$
Total polyphénols g/100g MS)	Bioch-ExtPlantes-05-fr	UCAD @ UCAD	3	$0,26^{a} \pm 0.001$	3	$0,26^{a} \pm 0.001$	3	$0,24^{b} \pm 0.002$	3	$0,15^{c} \pm 0.001$
Total anthocyanins g/100g MS)	Bioch-ExtPlantes-06-fr	UCAD @ UCAD	3	$0,093^{b} \pm 0.001$	3	$0,043^{d} \pm 0.001$	3	$0,049^{c} \pm 0.001$	3	$0,098^{a} \pm 0.001$