African Food Tradition rEvisited by Research
FP7 n°245025

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

Deliverable number: D 4.1.2.1

Title of deliverable: **Report with the list of constraints involved in the processing of products from *Hibiscus sabdariffa***

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

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

Contractual date of delivery: February 2012

Actual date of delivery: September 2012

Work-package contributing to the deliverable: WP 4

Organisation name of lead contractor for this deliverable: UCAD

Authors: Mady CISSE, Ndéye Adiara NDIAYE, Alé KANE, Nérovique GEMINA, Djibril DIATTARA, Malick DIOUF, Fallou Mbacké SAMBE, Cheikhou KANE, Mamadou FAYE, Mama SAKHO, Coumba TOURE KANE,.

This document has been send to :

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

* PU: Public; PP: Restricted to other programme participants (including the Commission Services); RE: Restricted to a group specified by the consortium (including the Commission Services); CO: Confidential, only for members of the consortium (including the Commission Services)

TABLE OF CONTENTS

1. Introduction

Hibiscus sabdariffa L. is an 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 ; Nyarko et al., 2006 ; Cisse et al., 2009a; Cisse et al., 2009b)

Originally in Sudan, *Hibiscus sabdariffa* was introduced in Senegal in the 19 th century (Kerharo & Adam, 1974). It is traditionally grown by women for local consumption of leaves and calyxes for the sauce, drinks and jams. Also, In Senegal, traditional processing of the *H. sabdariffa* calyx has been greatly improved by the establishment of many small enterprises.

Traditional food products (drink, syrup) from *Hibiscus sabdariffa* calyx are generally manufactured at home (in small scale) or small factories, enterprise (in semi industrial scale) with a lack of technical tools to control the quality.

It is in this context that many traditional firms manufacturing products from *Hibiscus sabdariffa* were diagnosed.

2. Sampling

Manufacturing processes of drink, syrup and powder from bissap were selected for this study. In fact, drink and syrup are the two main products from roselle calyx according the results of the survey (deliverable D 1.1.2.3). *Hibiscus sabdariffa* powder is also starting to appear on the local market.

Four companies named Dakar 1, Thies 1, Thies 2 and Kaolack 1 respectively located in Dakar, Thies and Kaolack were chosen (**Figure 1**) in order to avoid changing of the sample from collection to analysis. Further these three regions are considered to be the largest areas of consumption of products from bissap calyx. In each company the **table 1** indicates the products concerned and some special features.

Table 1. Some special features of the companies

Companies	Region	Products[1]	Number of people working in the production
Dakar 1	Dakar	*Drink, syrup*	
Thies 1	Thies	*Drink, syrup,* jams, powder	3
Thies 2	Thies	*Powder*	
Kaolack 1	Kaolack	*Drink, syrup,* jams	3

[1] Products involved in the diagnosis

Figure 1. Location of the companies

3. Methodology

Diagnoses were made with the consent and full cooperation of the companies concerned. For diagnosing a team of two people was chosen. Their role is to monitor all stages of process from raw material to finished product. The team simply note the manufacturing process carried out by the company itself. Moreover, in the preparation of these visits, companies were aware that the fact of our presence should not in any case make them change their way of working at all levels. The team brought with him a temperature sensor, a refractometer, pH paper and a cooler.

4. Results and discussion

4.1. General observation

Three (03) out of the four (04) companies are run by women who also handle the production. Only the company Thies 2, producing the bissap powder man belongs to a duo composed of one Senegalese and one French man. For this latest company, a woman is involved in the production of powder with two other men.

Production is carried out in family homes. In some cases, some small adjustments were made to separate production area from rooms housing. Production equipment used is rudimentary, artisanal, locally produced.

Operators comply with the good hygiene practices (washing hands, port gown, cap and gloves, change of shoes to go out and washing hands after entry, cleaning and disinfection of equipment and packaging material)

4.2. Manufacture of the beverage

Figures 2, 3 and **4** show respectively the process flow diagram for bissap drink according Dakar 1, Thies 1 and Kaolack 1 companies. The analysis of the figures shows many commonalities and some fundamental differences between processers.

Producers of Dakar 1 and Kaolack 1 used as raw material a mixture of two varieties of *Hibiscus sabdariffa* in a proportion of 50/50. Producer of Thies 1 manufactures the bissap drink from the aqueous extract used to make bissap syrup.

Final products are significantly different according total soluble solid Quantities of sugar introduced during the formulation stage are the main cause.

The **table 2** lists all the steps used in the process flow diagram of bissap, the concerned companies, the equipment used and the conditions (temperature, duration) for performing the step. The analysis of the table shows that all equipment used is not appropriate regardless of the step. All operations are manual. Some important steps such as heat treatment, packaging are not adequately monitored or controlled.

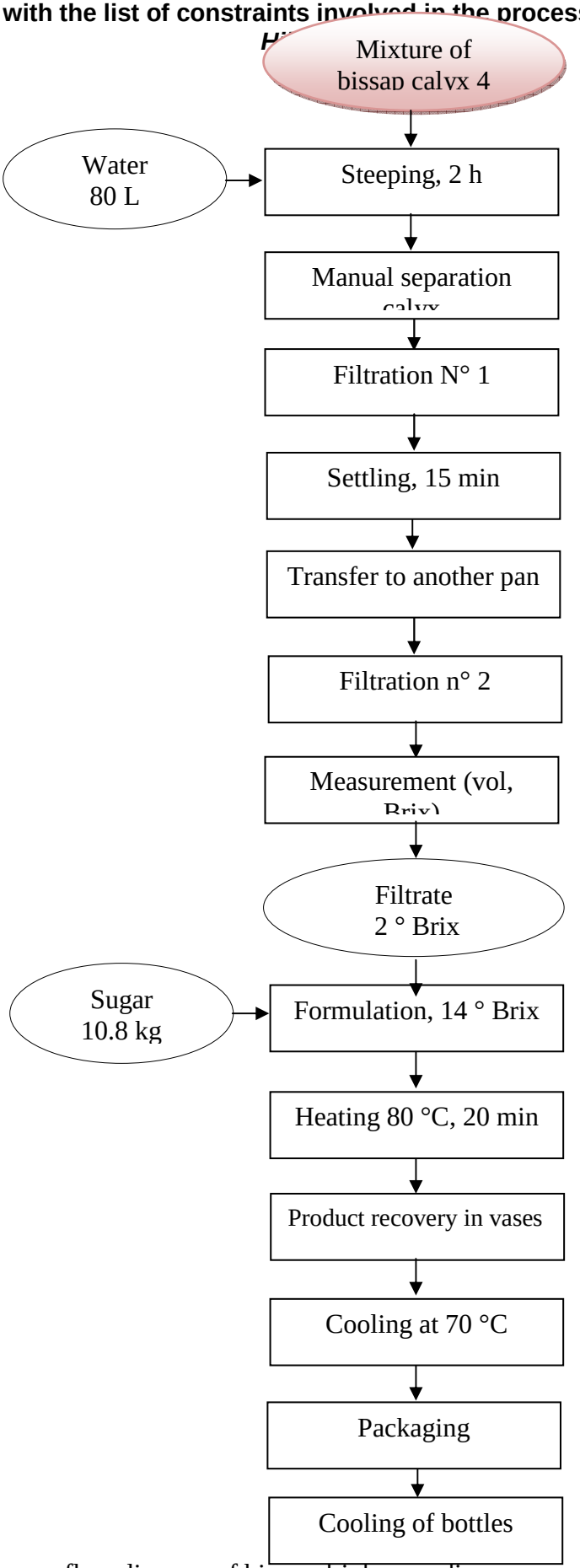

Figure 2. Process flow diagram of bissap drink according one company (Dakar 1) at Dakar

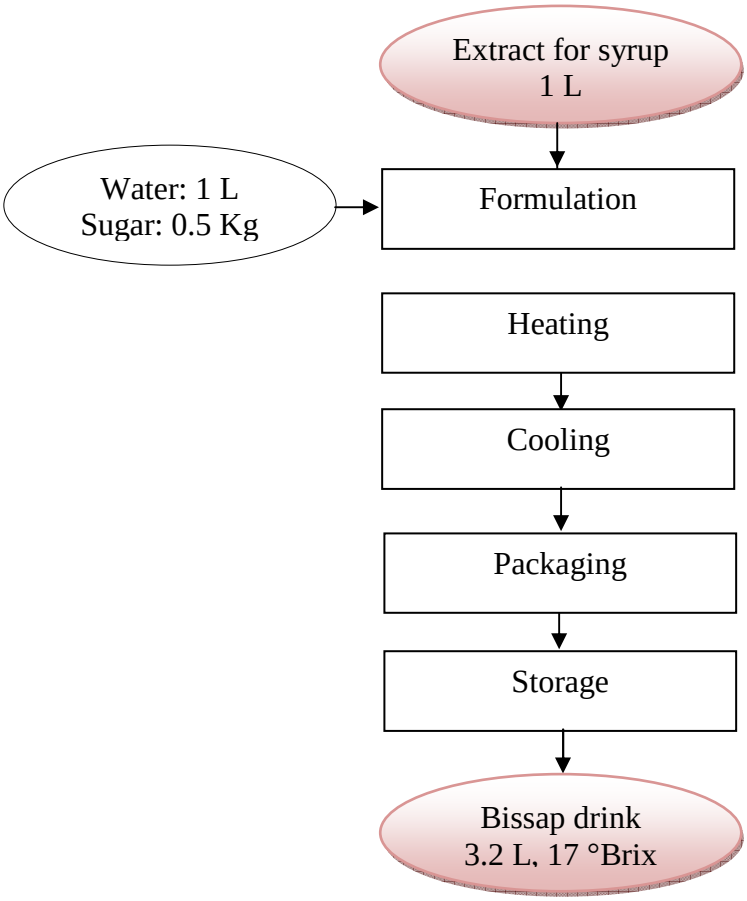

Figure 3. Process flow diagram of bissap drink according one company (Thies 1) at Thies

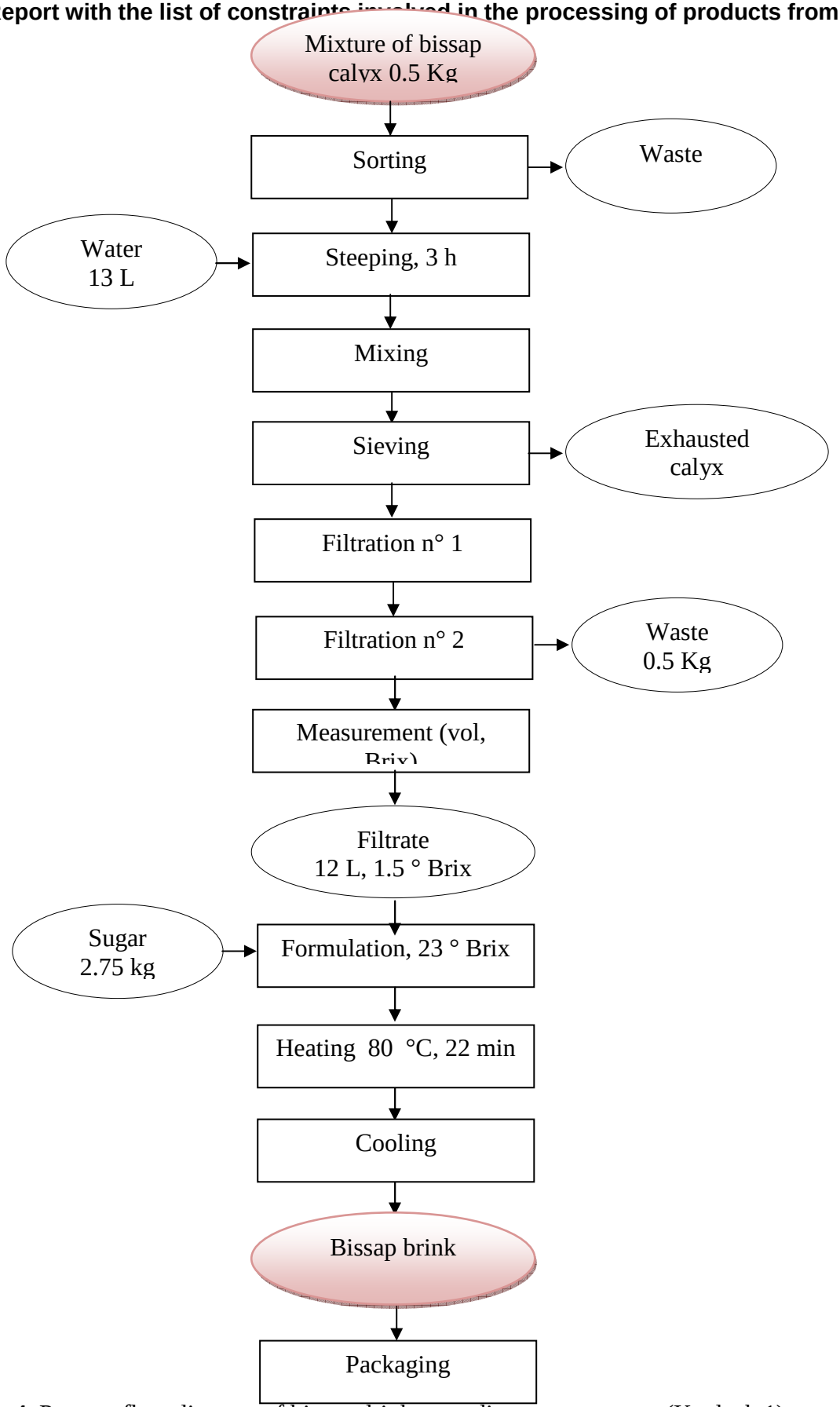

Figure 4. Process flow diagram of bissap drink according one company (Kaolack 1) at Kaolack

Table 2. Lists of all the steps used in the process flow diagram of bissap drink, the concerned companies, the equipment used and the conditions

Stage of process	Dakar 1	Thies 1	Kaolack 1	Equipment	Conditions (T, t)
Sorting			√	Manual	Room temperature, few minutes
Steeping	√		√	Pan, bucket, bowl	Ratio calyx/water : 1/20 to 1/30 Room temperature, 2 à 3 h
Separation of calyx	√			Manual	Room temperature
Mixing			√	Wood skimmer	
Sieving			√	Strainers	
Filtration	√		√	Light cloth , cotton wool, sieve	
Settling	√			Bowl	
Transfer	√			Pan, bucket, bowl	
Measurement	√		√	Graduated carafe, manual refractometer, mercury thermometer, ordinary balance	
Formulation	√	√	√	Cane sugar from Senegal or Gambia	Room temperature , ° Brix : 14-23
Heating	√	√	√	Cooking pot, flames obtained by gas combustion skimmer	Temperature > 80 °C Time : 20 -25 min
Cooling	√	√	√	Pan, bucket, bowl	Cooling with water at ambient temperature until to 70 °C
Packaging	√	√	√	Plastic bottles, glass bottles, plastic bag	To the ambient air, manual, temperature of product
Storage	√	√	√	Domestic refrigerator and freezer	Temperature : 6-10 °C Time : few days to several weeks

4.3 Manufacture of the syrup

Figures 5, 6 and **7** show respectively the process flow diagram for bissap syrup according Dakar 1, Thies 1 and Kaolack 1 companies. The analysis of the figures shows many commonalities and some fundamental differences between processers.

Process flow diagram of bissap syrup for Dakar 1 and Kaolack 1 producers are exactly the same as that of the beverage. Moreover, the same equipment is used. The differences are observed in the proportions calyx /water, the step of formulation and temperatures used during heat treatment. For syrup the ratio calyx/water is between 1/4 to 1/8. Total soluble solid of syrup vary from 650 to 850 $g.Kg^{-1}$. The heat treatment (15 to 20 min according the processer) involves heating under continues manual stirring until the temperature of 105 ° C. The product is then cooled to room temperature until 70 ° C before packaging. Thies 1 is the only company using potassium sorbate in order to stabilize the product.

Figures 8 show the photos of different steps during the manufacturing of bissap drink or/and syrup.

4.4. List of constraints during the process of drink and syrup

The overall analysis of different manufacturing processes is used to compile the table 3 that gives the observed constraints for each stage as well as general observations.

4.5. Reengineering

The constraints identified were able to propose some solutions shown in **Table 4**. To improve product quality, ensure consistent quality between batches of production, reengineering step is essential. In this context the optimization of pasteurization schedules and the study of the stability of the company's products Dakar 1 are in progress.

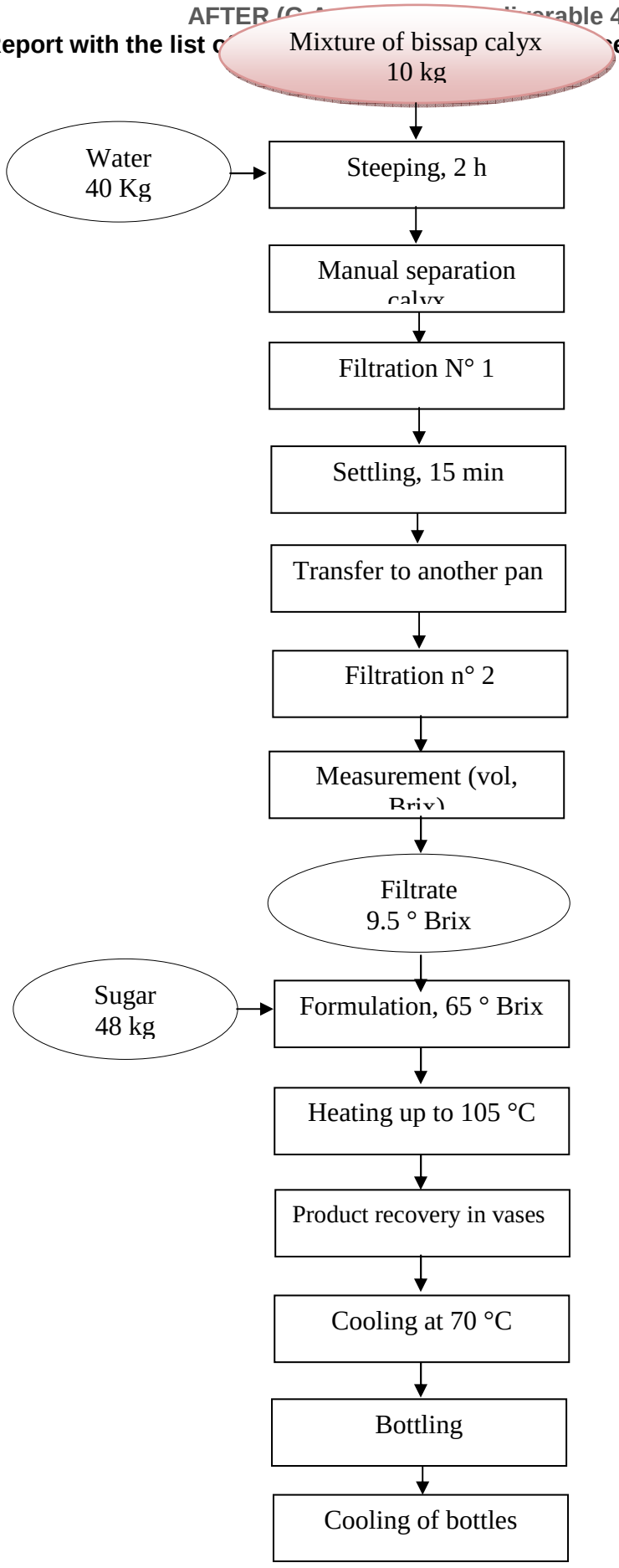

Figure 5. Process flow diagram of bissap syrup according one company (Dakar 1) at Dakar

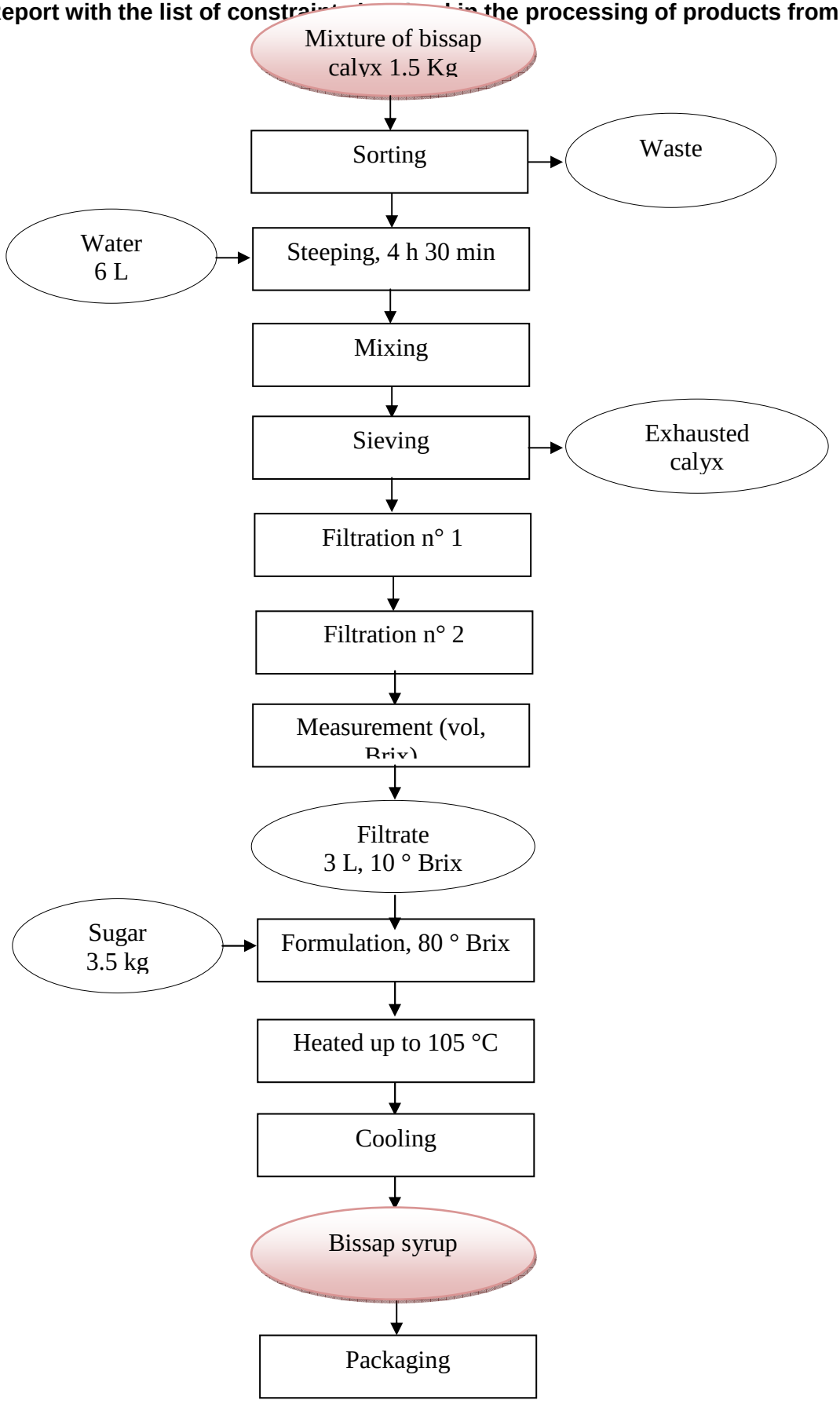

Figure 6. Process flow diagram of bissap syrup according one company (Kaolack 1) at Kaolack

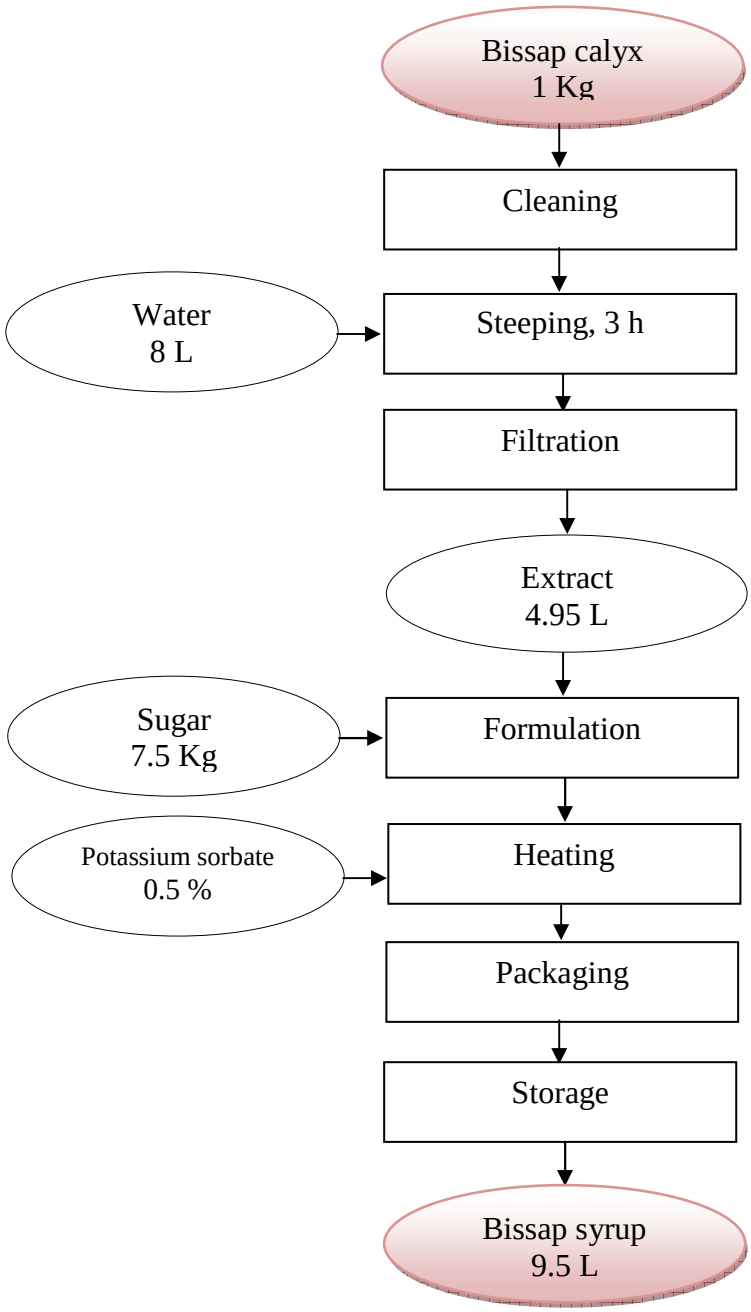

Figure 7. Process flow diagram of bissap syrup according one company (Thies 1) at Thies

Figure 8 . Photos illustrate the various stages of manufacture of bissap drink or/and syrup

Table 3. List of constraints for each stage during the process of bissap drink or/and syrup

	Constraints	Stage	Observations
Drink, syrup	Microbial contamination	All stages	Operations are almost all at room temperature in a domestic environment without special device to improve air quality
Drink, syrup	Gloves	Manual separation, filtration, measurement, heating, packaging	Some structures use inadequate gloves. The gloves used in the heat treatment step cannot avoid burns
Syrup	Sugar dissolves	Formulation	Dissolving the sugar is difficult and slow. It requires a long manual agitation and sometimes it is not completely dissolved thus altering the appearance of the product
Drink, syrup	No control of heat treatment	Heating	Difficulties in applying the good conditions (temperature/time) due to thermal heating by gas stove. Containing material used to be treated the products and the control instruments for temperature are not appropriate.
Drink, syrup	Cooling at air	Cooling	Cooling after heating is slow and source of recontamination of the product before packaging

Table 4. Examples of solutions for reengineering

Stage	Solutions for reengineering
All stages	Have an effective antiseptic, clean containers, use disposable gloves
	Effectively clean and sanitize equipment
	An approach to move forward. Separating at least weighing operations, sorting, soaking and filtration of other operations of the manufacturing process
	Do not prepare different products at the same time to avoid cross-contamination
	Change wash water and disinfection after each preparation of product
Steeping	Optimize this stage; time is between 2 and 3 h. Especially the characterization of the product shows that the extraction yield is very low (less than 50%). Grinding calyx will be an avenue
Filtration	Using bag filter system would be a good alternative
Measurement	Use of more precise measuring instruments (scales, graduated test tube, temperature probe)
Formulation	Using sugar syrup
Heating	Use of appropriate equipment (pasteurizer, cooker)
	Optimization scales pasteurization and cooking
Cooling	Use of chilled water
Packaging	Use a packaging for hot filling

4.6. Manufacture of the powder

Hibiscus sabdariffa powder is a new product made by a few companies. In our study only Thies 2 company produces powder of bissap. **Figure 9** gives the process diagram.

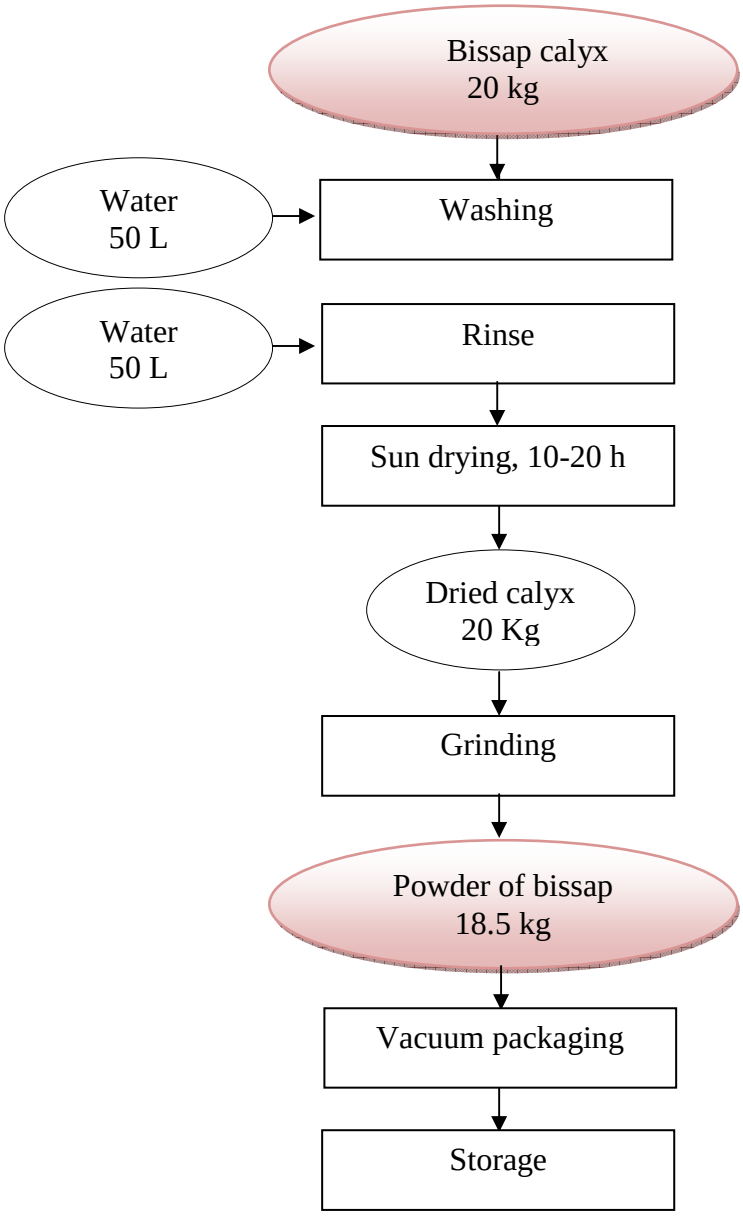

Figure 9. Process flow diagram of bissap powder according one company (Thies 2) at Thies

The overall analysis of the process is used to compile the **table 5** that gives the observed constraints for each stage as well as some recommendation for reengineering.

Table 5. Constraints and recommendation for reengineering for the production of bissap powder

Steps	Constraints	Reengineering
Washing/Rinse	High water consumption Losses of anthocyanins	✓ Choose a raw material with high quality ✓ Use a dry cleaning to remove foreign bodies (debris sand, stone, etc.)
Drying	Significant duration Requires significant space Losses of anthocyanins	✓ Choose a raw material with high quality ✓ Use a dry cleaning to remove foreign bodies (debris sand, stone, etc.)
Grinding	Inappropriate grinder Heterogeneity in the size of the powder Labor intensive	✓ Appropriate grinder ✓ Screening and calibrating system for the powder
Vacuum packaging	Significant duration Inappropriate equipment	✓ Appropriate equipment

5. Conclusion

As a whole, the working conditions are acceptable within the structure visited. Operators used cover, do not wear jewelry and changed shoes before to go out. However, some measures can be recommended:

- Good hygiene and manufacturing practices can be improve
- Review the dosage of the antiseptic solutions and to create a map of renewal products to avoid the resistor of microorganisms for the cleaning and disinfection solutions.
- Introduce the principle of the forward. At least separate clean and soiled areas. Do not make the entire production process in the same enclosure.
- Consider the implementation of HACCP method.
- Better supply of the raw material in order to have a consistent product quality.

Further work is underway with two companies (Dakar 1 and Thies 2) in the reengineering step. Also, the optimization of pasteurization schedules and the study of the stability of the company's products Dakar 1 and Thies 2 are in progress.

References

Babalola S.O., Babalola A.O. & Aworh O.C. 2001. Compositional attributes of the calyces of roselle (*Hibiscus sabdariffa*), *J. Food Technol. Afr*. 6 (4), 133–134.

Cisse M, Dornier M., Sakho M., Diop C.M., ReyneS M. & Sock O. 2009a. La production de bissap (*Hibiscus sabdariffa*) au Sénégal *Fruits*, 64, p. 111–124.

Cisse M, Dornier M., Sakho M., Ndiaye A., Reynes M. & Sock O. 2009b. Le bissap (*Hibiscus sabdariffa* L.) : composition et principales utilisations *Fruits*, 64, (3) p. 179–193.

Glew R.H., VanderJagt D.J., Lockett C., Grivetti L.E., Smith G.C., Pastuszyn A. & Millson M. 1997. Amino acid, fatty acid, and mineral composition of 24 indigenous plants of Burkina Faso. *J. Food Compos. Anal.* 10, 205–217.

Lorenzo D., Atti-Serafini L., Santos A., Frizzo C.D., Paroul N., Paz D., Dellacassa E. & Moyna P. 2000. *Achyrocline satureioides* essential oils from southern Brazil and Uruguay. *Planta Medica* 66, 476–477.

McClintock N.C. & El Tahir I.M. 2004. *Hibiscus sabdariffa* L., in : Grubben G.J.H., Denton O.A. (Eds.), PROTA 2 (*Plant Resources of Tropical Africa*): vegetables [CD-Rom], PROTA Wagening., Neth..

Morton J.F. & Roselle, M.J. in: Dowling C.F. (Ed.), 1987. Fruits of warm climates, Media, Inc., Greensboro, NC, USA, pp. 281–286.