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RESEARCH ARTICLE

OPTIMIZATION OF MUCILAGE EXTRACTION METHODS FROM FEW FOOD PLANTS OF IVORIAN FLORA USING EXPERIMENTAL DESIGN

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ABSTRACT

The interest of Côte d'Ivoire populations in mucilaginous food plants caused the use of experimental design to optimize mucilage extraction methods. So, 6 technological parameters have been selected. It is about the delipidation (X_1), the ratio vegetal/water (X_2), the steeping time (X_3), the heating time (X_4), the ratio filtrate/ethanol (X_5) and the refrigeration time (X_6). Plackett and Burman design and full factorial design application permitted to optimize mucilage extraction of this food plants. The results showed that delipidation is the most significant parameter for *Irvingia* kernels and it contributed to 100% in mucilage yield variation. The ratio vegetal/water and steeping time contributed to 12.37% and 11.96% respectively. To the level of the leaves, the most significant parameters are the steeping time (84.24%), the ratio vegetal/water (79.02%) and the heating time (48.34%). Optimal process application gave the experimental answers of 56.34±0.42% and 25.81±0.39% appreciably equal to the answers predicted by the mathematical computations that were respectively of 55.75% and 27.04% for the kernels and the leaves.

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INTRODUCTION

Côte d'Ivoire farming populations, like all human societies, benefit from food, medicinal plants, spices and herbs coming from plants species being in their immediate environment. These different products knew like provision services, constitute important elements of the economy of these households and their food security (Asaah *et al.*, 2011; Maghembe *et al.*, 1994; FAO 2011). In these forests, abound a multitude of plants varieties which are eaten by the populations (FAO, 2010; Franzel *et al.*, 2008; Nikiema, 2005) attracted by their organoleptic characteristic and their availability (Arnold *et al.*, 2011; N'gosso, 2014). So populations of some regions of Côte d'Ivoire made mucilaginous food plants the dishes of choice based on the gluey aspect brought to sauces. The possibilities of mucilaginous plants use are numerous. Besides the culinary aspect, mucilages extracted are used in the agroalimentary, pharmaceutical and cosmetic domains (Dickinson, 2003; Siemonsma and Kouame, 2004; Kochhar, 1986; Schalau, 2002). The mucilaginous plants can be considered like functional food thanks to their regulation properties of health several parameters (diabetes, blood-pressure, cholesterol). They possess organoleptic properties and cut hunger (Ishida *et al.*, 2000; Mensah *et al.*, 2008; Schalau, 2002). Incontestably, mucilages have very nutritional importance and also multitude extraction methods with very often many parameters (Rajendra and Shende, 2015; Ogaji *et al.*, 2012; Ngwuluka *et al.*, 2012). Through experimental designs application, to optimize mucilages extraction from organs (kernels, fruits, leaves, flowers and calyx) of 9 mucilaginous food plants to know *Irvingia gabonensis* (IG),

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Irvingia wombolu (IW), *Bombax buonopozense* (BB), *Adansonia digitata* (AD), *Beilschmiedia mannii* (BM), *Corchorus olitorius* (CO), *Myrianthus arboreus* (MA) and varieties koto and tomi of *Abelmoschus esculentus* (AE), such is the aim of our study. Experimental designs permit the experimentation in a minimal number of experiences while giving the possibility to make a sifting of the factors to select some most significant. They permit to optimize operative conditions in order to reach the best possible result (Biego and Chatigre, 2015; Koffi *et al*., 2015; Amane *et al*., 2012). We used Plackett and Burman matrixes with 2 levels to make screening designs of factors (Plackett and Burman, 1946). The experimentation consisted in putting in evidence the effects of some factors on answers studied (Adjé *et al*., 2010). The use of experimental designs in the analysis and the optimization of the extraction process have been evoked by several authors (Koffi *et al*., 2015; Amane *et al*., 2012; Plackett and Burman, 1946; Adjé *et al*., 2010; Nyamien *et al*., 2015; Wognin *et al*., 2010). Six technological parameters identified were the delipidation, the ratio vegetable/water, the steeping time, the heating time, the ratio filtrate/ethanol and the refrigeration time. After the sifting of parameters by Plackett and Burman design, the most significant served in a full factorial design to 2 levels to optimize mucilage yield.

MATERIALS AND METHODS

Plant material

The biological material is constituted of different edible parts of 9 mucilaginous plants exits of Ivorian flora. It's notably about *Irvingia gabonenesis* (IG), *Irvingia wombolu* (IW), *Bombax buonopozense* (BB), *Adansonia digitata* (AD), *Beilschmiedia mannii* (BM), *Corchorus olitorius* (CO), *Myrianthus arboreus* (MA) and varieties of koto and tomi of *Abelmoschus esculentus* (AE). The kernels (IG and IW), the leaves (CO, AD, MA and BB), the fruits (BM and AE), the calyx and the flowers (BB) that constitute the parts consumed by several populations of Côte d'Ivoire have been collected (Table 1). These plants have been authenticated by the Centre National de Floristique (CNF) of the university Felix HOUPHOUET-BOIGNY.

Samples processing

The acquirement of the plants has been done in 3 big regions (Tonkpi, Bélier and District of Abidjan) of Côte d'Ivoire of January 2013 to December 2014. To achieve this study, 100 kg of fresh fruits and masts of the species *I. gabonensis, I. wombolu* and *B. mannii* have been bought to the farmer in the region of the Tonkpi. A same quantity of leaves, calyx and flowers of *B. buonopozense* has been harvested in the region of Bélier. As well as 100 kg of leaves of *C. olitorius*, *M. arboreus*, *A. digitata* and varieties tomi and koto of *A. esculentus* have been bought to the Gouro market in the District of Abidjan. In each of the regions, the different products have been collected to 3 farmers or sellers.

Treatment of the mucilaginous plants

The fruits of *Irvingia* have been stocked several days then the seeds have been ground to isolate the kernels. As for the fruits of *B. mannii*, they have been cut in small pieces (less than 5 mm of thickness) before drying. In return, the fruits of *A. esculentus* (gumbo) have been cut in gill, whereas the leaves, the calyx and the flowers were sorted, cleaned and drained before being dried. After drying, plants parts collected have been reduced in powder with a grinder of Heavy Duty mark (Fig 1).

Method of mucilage extraction

Fifty (50) g of leaves and kernels powder was delipided with hexane then macerated in 500 ml of water during 24 h. The mixture has been boiled during 1 h then filtered on muslin bag. The volume of the filtrate has been brought back to 100 ml after evaporation with the rotary evaporator. Then 3 volumes of ethanol have been added to the extract and the mixture has been placed at the refrigerator during 24 h. Mucilages have been recovered after filtration and then dried in an oven at 50°C. The extraction yield has been determined (Kolhe *et al*., 2014).

Application of Plackett and Burman design

Plackett and Burman design has been used for the mucilage extraction. So 6 factors represented by 6 technological parameters have been identified. It is about the delipidation (X_1), the ratio vegetal/water (X_2), the steeping time (X_3), the heating time (X_4), the ratio filtrate/ethanol (X_5) and the refrigeration time (X_6) (Table 2). This design permitted to achieve 8 tests while combining the lower levels (-1) and superior (+1) of the 6 chosen parameters (Plackett and Burman, 1946).

Statistical evaluation of Plackett and Burman design tests

The different results of mucilage extraction of the kernels and leaves are bound to the technological parameters in the shape:

$$\mathbf{Y_n = a_0 + \Sigma\, a_i X_i.}$$

This equation represent Y= f(X) and is a system to solve thanks to the coefficients determined from each of the parameters. This determination has been made from the multiple linear regression right (Feinberg, 1996) with the utility of Microsoft Excel analysis. Coefficient is known as statistically significant if its absolute value is strictly higher than the double of the experimental standard deviation, $|coef| > 2\sigma$ (Assidjo *et al*., 2005).

Application of full factorial designs

The full factorial designs at 2 levels have been achieved to determine the existing relation between the answers and the independent parameters and the impacts of their interactions (28). For the kernels, 5 influential parameters have been obtained. It is about the delipidation (X_1), the ratio vegetal/water (X_2), the steeping time (X_3), the heating time (X_4) and the refrigeration time (X_6). They permitted the realization of 32 tests (Table 3). Concerning the leaves, the retained parameters were the delipidation (X_1), the ratio vegetal/water (X_2), the steeping time (X_3) and the heating time

(X_4). While combining these 4 factors with the 2 levels, 16 tests have been achieved (Table 4).

Statistical evaluation of full factorial design tests

Results obtained are bound to the technological parameters by a relation of the shape:

$$Y_n = b_0 + b_1X_1 + b_2X_2 + \dots b_kX_k + b_{12}X_1X_2 + \dots + b_{k-1k}X_{k-1}X_k + \dots + b_{1\dots k}X_1X_2\dots X_k$$

Where **Yn** was the measured response; **bk** the main effect of factor **Xk**, **bk-1k** the interaction effect between factors **Xk** and **Xk-1** and **b0** the constant term. This equation is there the shape Y= f(X) and represent a system to solve thanks to the coefficients determined from each of the parameters. This determination has been made from the multiple linear regression right (Feinberg, 1996) with the utility of Microsoft Excel analysis. Coefficient is known as statistically significant if its absolute value is strictly higher than the double of the experimental standard deviation, |coef|> 2σ (Assidjo *et al.*, 2005).

Statistical analysis

All experiments were done in triplicate and data in tables and figures represent mean values ± standard deviation (n=3). Coefficient and experimental standard deviations were determined by the method of linear regression (MS Excel 2007). Comparison of mean values of measured parameters was performed by a one-way ANOVA (STATISTICA, version 7.1) using post hoc Low Statistical Difference (LSD) test. The mean values were considered significantly different when *P*=0.05.

RESULTS

Plackett and Burman design

During the mucilage extraction, Plackett and Burman design permitted to reduce the tests to 8. Then it gave the first results of experimental quantities of mucilages in the kernels and the leaves (Table 5). The statistical evaluations of the coefficients of regression of this design are presented in the Table 6.

Table 1. Some mucilaginous food plants of Ivorian flora

Designation	Family	Local name	Edible parts
Irvingia gabonensis (Aubry Lecomte)	Irvingaceae	Kaclou, kple	kernels
Irvingia wombolu (Vermoesen)	Irvingaceae	Kaclou, kple	kernels
Bombax buonopozense (P.Beauv)	Bombacaceae	Kapokier	calyx, leaves, flower
Corchorus olitorius(Linn)	Tiliaceae	Kplala	Leaves
Adansonia digitata (Linn)	Bombacaceae	Baobab	Leaves
Myrianthus arboreus (P.Beauv)	Cecropiaceae	Tikliti	Leaves
Beilschmiedia mannii (Meisn)	Lauraceae	Tlan	Fruits
Abelmoschus esculentus(Linn) var. tomi	Malvaceae	Gumbo baoule	Fruits
Abelmoschus esculentus (Linn) var. koto	Malvaceae	Gumbo dioula	Fruits

Table 2. Parameters and levels for Plackett and Burman design

Factors	Technological parameters	Code levels	
		-1	**+1**
X_1	Delipidation	No	Yes
X_2	Ratio vegetal/water (w/v)	10/500	50/500
X_3	Steeping time (h)	2	24
X_4	Heating time (h)	0	1
X_5	Ratio filtrate/ethanol (v/v)	1/1	1/3
X_6	Refrigeration time (h)	0	24

Table 3. Parameters and levels for kernels full factorial design

Factors	Technological Parameters	Code levels	
		-1	**+1**
X_1	Delipidation	No	Yes
X_2	Ratio vegetal/water (w/v)	10/500	50/500
X_3	Steeping time (h)	2	24
X_4	Heating time (h)	0	1
X_6	Refrigeration time (h)	0	24

Table 4. Parameters and levels for leaves full factorial design

Factors	Technologic Parameters	Code levels	
		-1	**+1**
X_1	Délipidation	No	Yes
X_2	Ratio vegetal/water (w/v)	10/500	50/500
X_3	Steeping time (h)	2	24
X_4	Heating time (h)	0	1

Table 5. Plackett and Burman design tests

Tests	Technological Parameters levels						Experimental answers	
	X_1	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**	**Y_k (kernels)**	**Y_l(leaves)**
1	+	+	+	-	+	-	54.48±0.25	24.62±0.07
2	-	+	+	+	-	+	0	25.28±0.54
3	-	-	+	+	+	-	0	26.70±0.11
4	+	-	-	+	+	+	56.70±0.14	25.90±0.29
5	-	+	-	-	+	+	0	24.34±0.05
6	+	-	+	-	-	+	58.20±0.08	26.10±0.75
7	+	+	-	+	-	-	53.34±0.51	24.36±0.33
8	-	-	-	-	-	-	0	25.50±0.46

Table 6. Coefficients statistical estimations of Plackett and Burman design

Coefficient	Coefficients values and standard deviation			
	Kernels		**Leaves**	
	values	**2σ**	**values**	**2σ**
a_0	**27.84****	0.09	**25.35****	0.05
a_1	**27.84****	0.09	**-0.11***	0.05
a_2	**-0.89***	0.09	**-0.7***	0.05
a_3	**0.33***	0.09	**0.33***	0.05
a_4	**-0.33***	0.09	**0.21***	0.05
a_5	-0.05	0.09	0.04	0.05
a_6	**0.89***	0.09	0.05	0.05

* : significant

Table 7. Kernels full factorial design tests

N° Tests	Parameters levels					Extraction results
	X_1	**X_2**	**X_3**	**X_4**	**X_6**	**Y**
1	No	1/50	2h	0h	0h	0
2	Yes	1/50	2h	0h	0h	55.13±0.44
3	No	1/10	2h	0h	0h	0
4	Yes	1/10	2h	0h	0h	54.48±0.33
5	No	1/50	24h	0h	0h	0
6	Yes	1/50	24h	0h	0h	58.24±0.18
7	No	1/10	24h	0h	0h	0
8	Yes	1/10	24h	0h	0h	55.05±0.18
9	No	1/50	2h	1h	0h	0
10	Yes	1/50	2h	1h	0h	56.11±0.37
11	No	1/10	2h	1h	0h	0
12	Yes	1/10	2h	1h	0h	54.89±0.23
13	No	1/50	24h	1h	0h	0
14	Yes	1/50	24h	1h	0h	58.37±0.09
15	No	1/10	24h	1h	0h	0
16	Yes	1/10	24h	1h	0h	55.44±0.11
17	No	1/50	2h	0h	24h	0
18	Yes	1/50	2h	0h	24h	56.71±0.20
19	No	1/10	2h	0h	24h	0
20	Yes	1/10	2h	0h	24h	55.09±0.18
21	No	1/50	24h	0h	24h	0
22	Yes	1/50	24h	0h	24h	57.77±0.19
23	No	1/10	24h	0h	24h	0
24	Yes	1/10	24h	0h	24h	54.93±0.29
25	No	1/50	2h	1h	24h	0
26	Yes	1/50	2h	1h	24h	56.19±0.14
27	No	1/10	2h	1h	24h	0
28	Yes	1/10	2h	1h	24h	54.68±0.10
29	No	1/50	24h	1h	24h	0
30	Yes	1/50	24h	1h	24h	57.45±0.65
31	No	1/10	24h	1h	24h	0
32	Yes	1/10	24h	1h	24h	55.36±0.29

Table 8. Coefficients statistical estimations of kernels full factorial design

Coefficients	Coefficients values and standard deviation	
	values	**2σ**
b_0	**27.99****	0.14
b_1	**27.99****	0.14
b_2	**-0.5***	0.14
b_3	**0.29***	0.14
b_4	0.034	0.14
b_6	0.015	0.14
b_{12}	**-0.5***	0.14
b_{13}	**0.29***	0.14
b_{14}	0.034	0.14
b_{23}	**-0.19***	0.14
b_{24}	0.017	0.14
b_{34}	0.005	0.14

* : significant

Table 9. Leaves full factorial design tests

N° Tests	Parameters levels				Extraction results
	X_1	X_2	X_3	X_4	Y
1	No	1/50	2h	0h	24.68±0.35
2	Yes	1/50	2h	0h	25.11±0.88
3	No	1/10	2h	0h	25.34±0.06
4	Yes	1/10	2h	0h	25.41±0.41
5	No	1/50	24h	0h	26.71±0.22
6	Yes	1/50	24h	0h	26.89±0.05
7	No	1/10	24h	0h	25.63±0.01
8	Yes	1/10	24h	0h	25.51±0.49
9	No	1/50	2h	1h	25.78±0.26
10	Yes	1/50	2h	1h	26.32±0.04
11	No	1/10	2h	1h	25.60±0.58
12	Yes	1/10	2h	1h	25.53±0.07
13	No	1/50	24h	1h	27.05±0.35
14	Yes	1/50	24h	1h	26.82±0.06
15	No	1/10	24h	1h	25.67±0.58
16	Yes	1/10	24h	1h	25.44±0.11

Table 10. Coefficients statistical estimations of leaves full factorial design

Coefficients	Coefficients values and standard deviation	
	values	**2σ**
b_0	**25.84****	0.1
b_1	0.04	0.1
b_2	**-0.33***	0.1
b_3	**0.37***	0.1
b_4	**0.18***	0.1
b_{12}	-0.08	0.1
b_{13}	-0.09	0.1
b_{14}	-0.03	0.1
b_{23}	**-0.33***	0.1
b_{24}	**-0.14***	0.1
b_{34}	**-0.15***	0.1

* : significant

Table 11. Experimental validation of kernels full factorial design

Optimal conditions	Mucilage yield (%)	
	Expérimental	Predict
X_1 = Delipidation (Yes) X_2 = Ratio vegetal/water (10/500) X_3 = steeping time (24h)	56.34±0.42^{a}	55.75^{a}

Table 12. Experimental validation of leaves full factorial design

Optimal conditions	Mucilage yield (%)	
	Experimental	**Predict**
X_2 = Ratio vegetal/water (10/500) X_3 = steeping time (24h) X_4 = heating time (1h)	25.81±0.39^{b}	27.04^{b}

The delipidation, the ratio vegetal/water, the steeping time, the heating time and the refrigeration time were the most influential factors in the mucilage extraction of the kernels (Table 6). To the level of the leaves, these are the délipidation, the ratio vegetal/water, the steeping time and the heating time (Table 6).

Full factorial design

A full factorial design has been used to determine the best conditions of mucilage extraction. The tests design of the main parameters and the experimental results of kernels and leaves are presented respectively in the tables 7 and 9. The results of mucilage yields are bound to the main parameters by the relation of the shape:

$$\mathbf{Y_1 = b_o + b_1 X_1 + ... + b_4 X_4 + b_{12} X_1X_2 + ... + b_{14} X_1X_4 + b_{23} X_2X_3 + b_{24} X_2X_4 + b_{34} X_3X_4}$$

With the help of the result of every answer, the coefficients attached to every effect of main factors and interactions are calculated by the multiple linear regression method. The choice of influential factors is made by the test of coefficient significance. Indeed, coefficients selected are those whose absolute value is superior to the double of the experimental standard deviation (Assidjo *et al*., 2005). The data statistical analysis of kernels showed that the parameters (the delipidation, the ratio vegetal/water, the steeping time) and their interactions are the most significant factors (Table 8). The graphic studies of the answer (**Fig 2**) indicate these factors also like the most significant in the optimization of mucilage extraction. Their equation is with a value satisfactory of R^2 (R^2 = 1):

$$\mathbf{Y_k = 27.99 + 27.99\,X_1 - 0.5\,X_2 + 0.29\,X_3 - 0.5\,X_1X_2 + 0.29\,X_1X_3 - 0.19\,X_2X_3}$$

During the extraction, delipided samples provided the strongest contents (57%) with the ratio 1/50, while the ratio 1/10 gave only 54.99%, either a difference of 2.01%. Also delipided samples and steeping during 24 h displayed 1.17% of content besides in mucilages. The interactions between the ratio and the steeping time showed that, some either the steeping time, the ratio 1/50 provided the strongest contents (28.98% and 28.02%) in mucilages that the ratio 1/10 (**Fig. 3**).

To the level of leaves, the ratio vegetal/water, the steeping time, the heating time and their interactions are the most significant factors (Table 10). The graphic studies of the answer (**Fig 4**) indicate the same factors also like the most significant. Their equation is with R^2 (R^2 = 0.99):

$$\mathbf{Y_k = 27.99 + 27.99\,X_1 - 0.5\,X_2 + 0.29\,X_3 - 0.5\,X_1X_2 + 0.29\,X_1X_3 - 0.19\,X_2X_3}$$

A steeping of 24 h, increased the mucilages contents respectively of 5.21% and 0.35% for the ratios 1/50 and 1/10. The contents have also been improved respectively of 2.41% and 0.35% for the ratios 1/50 and 1/10 when the samples have been heated during 1h. The interactions between the heating and the steeping increased mucilages yields of 1.67% and 3.76% at the end of 24 h of steeping, when 1 h of heating raised them of 2.63% and 0.19% (**Fig 5**).

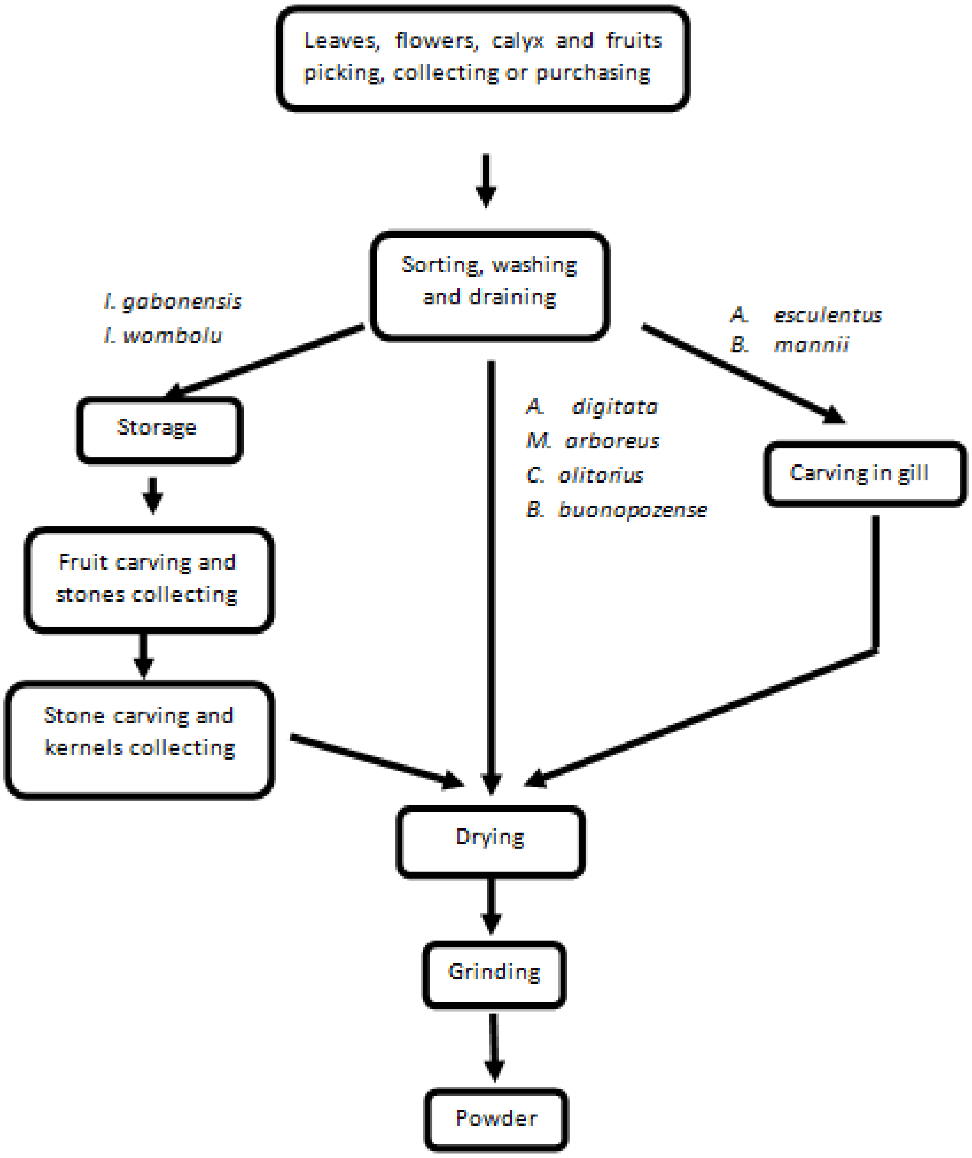
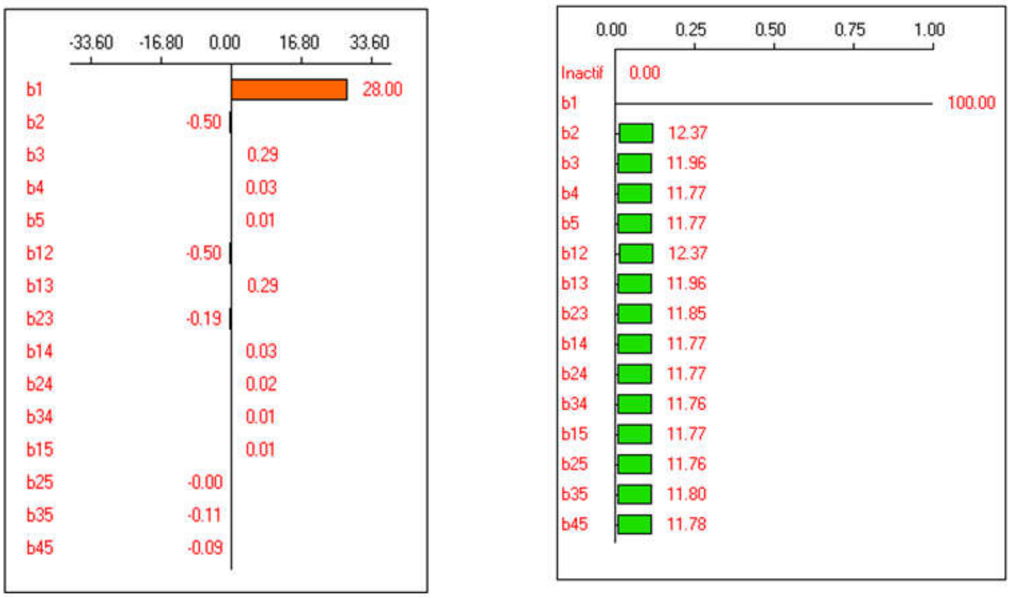
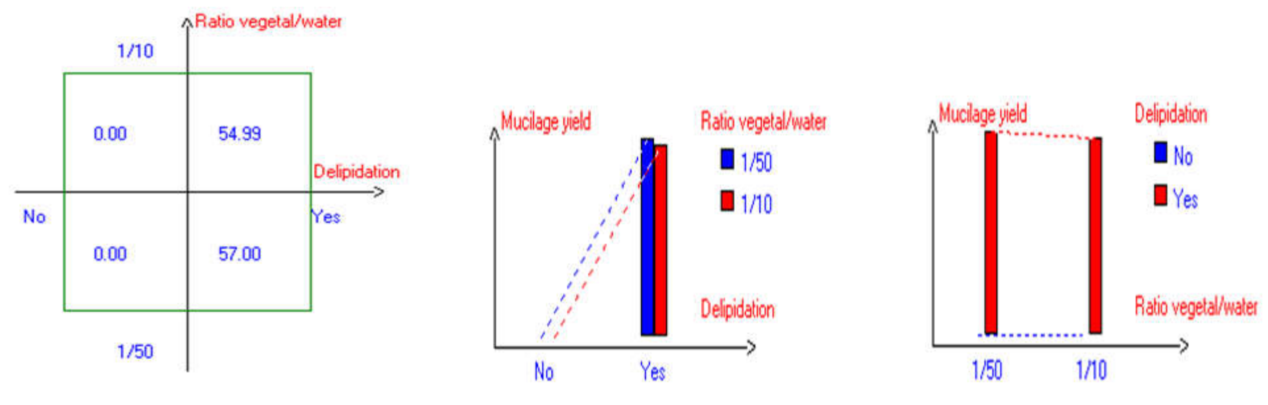


Fig.1. Drying methods of plants parts

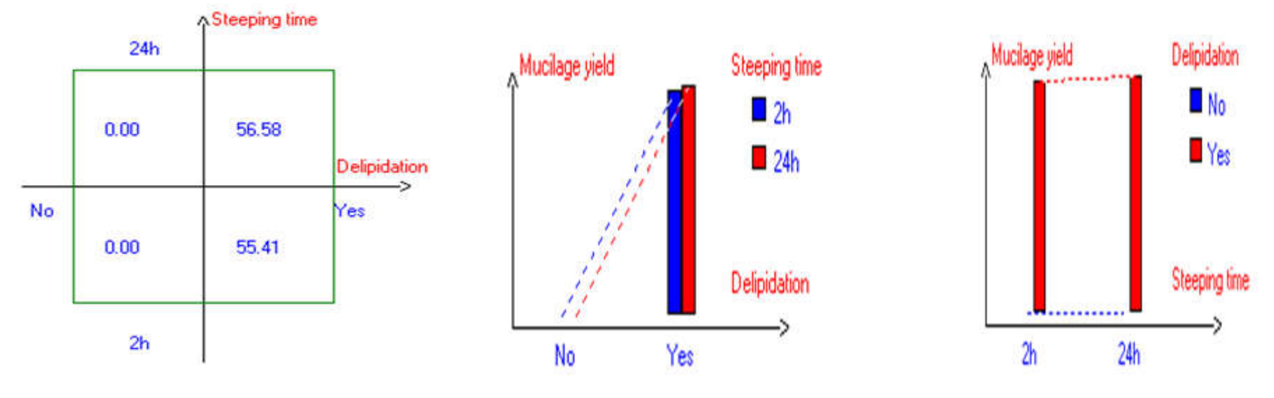


a b

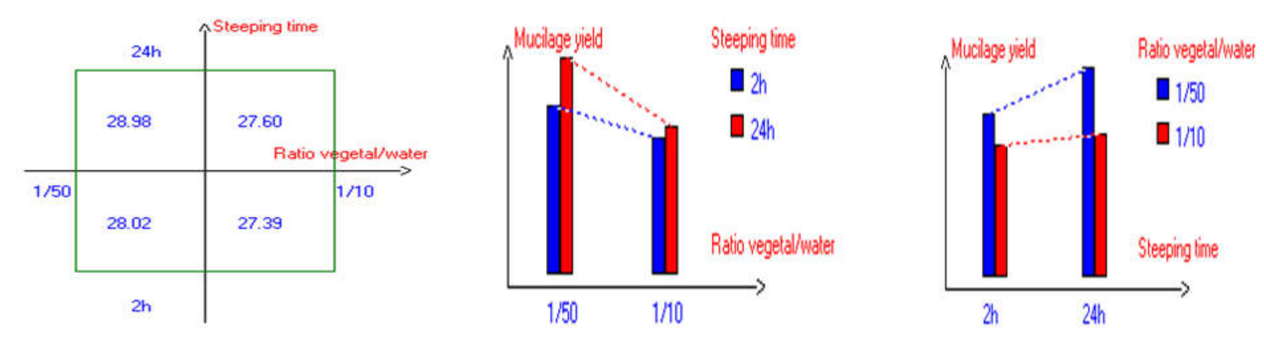
Fig. 2. Graph a: factors effects and graph b: contribution percentage of the factors in kernels answers variation (Y_k)



a- Interaction delipidation / ratio on mucilage yield

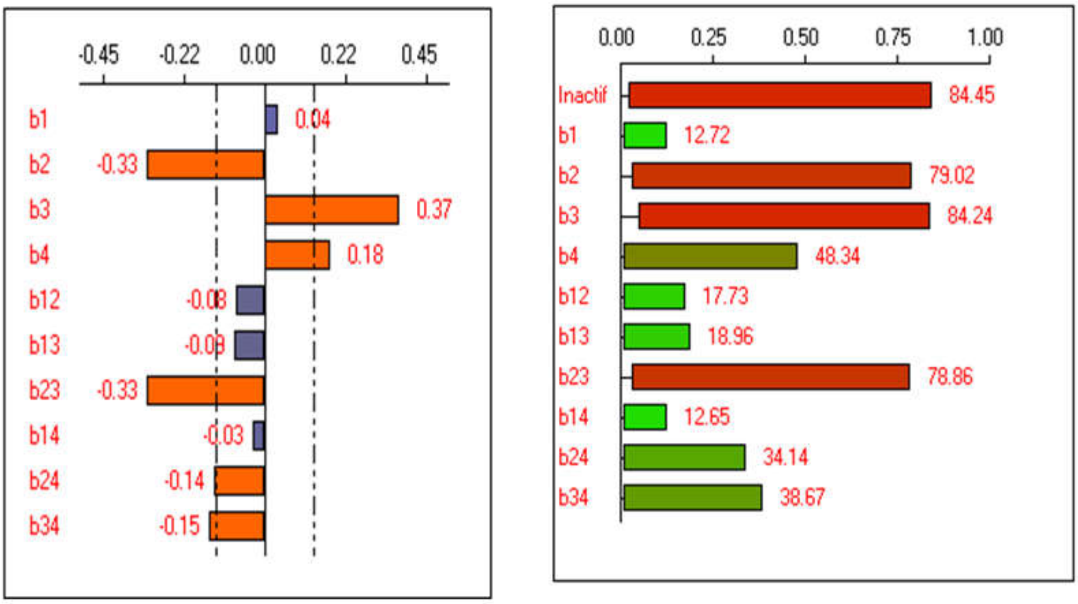


b- Interaction delipidation / steeping time on mucilage yield



c- Interaction ratio / steeping time on mucilage yield

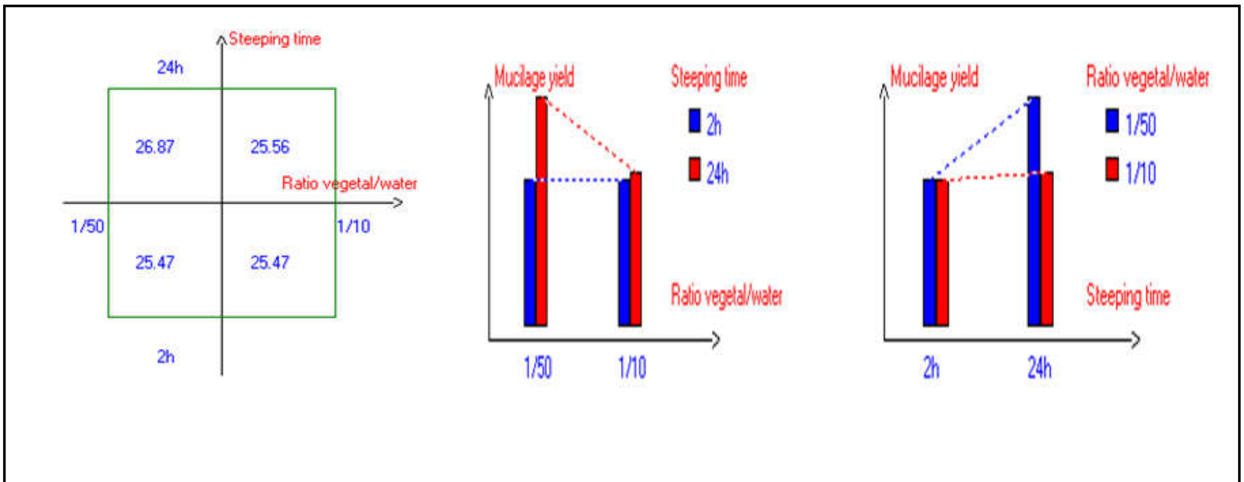
Fig. 3. Factors interactions influencing kernels mucilage yield



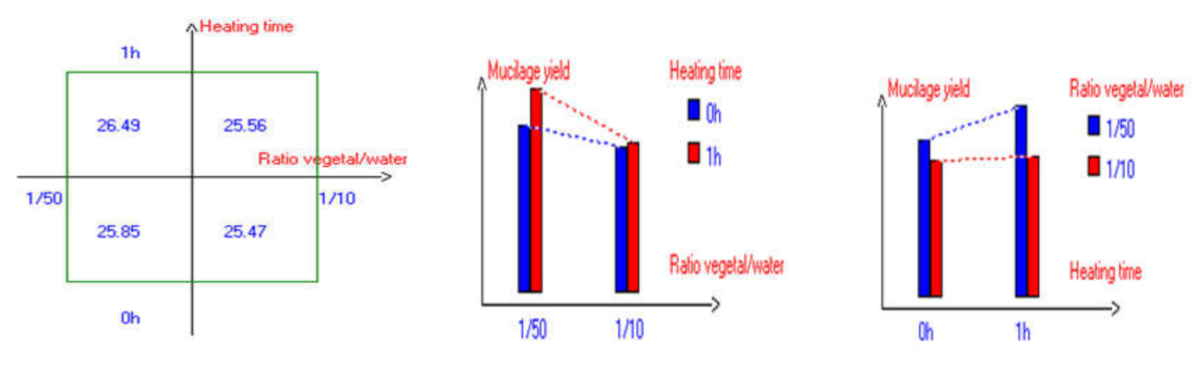
a

b

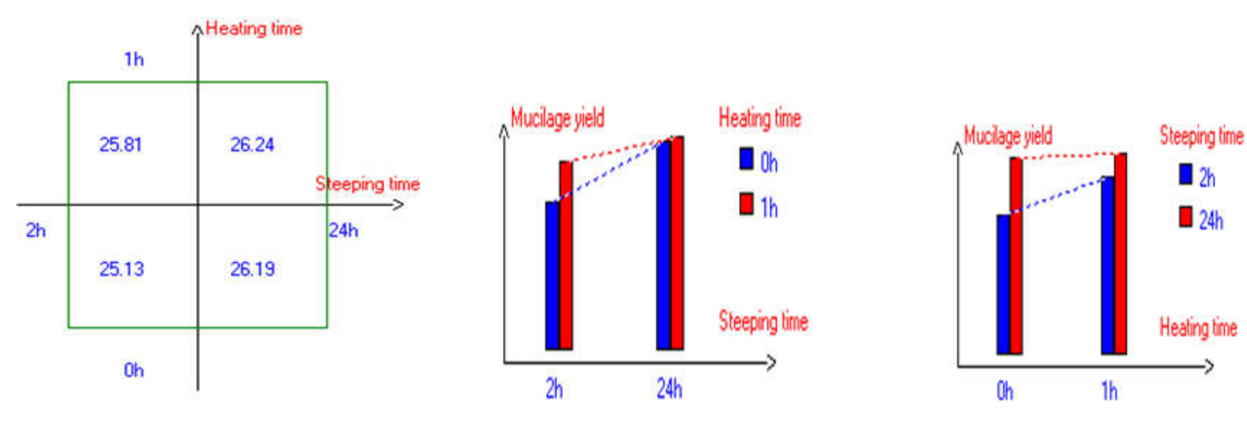
Fig. 4. Graph a: factors effects and graph b: contribution percentage of the factors in leaves answers variation (Y_l)



d- Interaction ratio/ steeping time on mucilage yield



e- Interaction ratio / heating time on mucilage yield



f- Interaction steeping time / heating time on mucilage yield

Fig. 5. Factors interactions influencing leaves mucilage yield

DISCUSSION

The use of experimental design in the optimization of mucilages extraction of mucilaginous food plants proved to be very interesting. Plackett and Burman design and full factorial design permitted to distinguish the most influential parameters. To the level of the kernels, design showed that the heating time, the ratio filtrate/ethanol and the refrigeration time are non significant factors (Table 8). Design identified the délipidation as the most important factor because it contributes to 100% in the mucilage extraction (**Fig. 2**). Then the ratio and the steeping time contribute to 12.37% and 11.96% respectively (**Fig. 2**). To the level of the leaves, the délipidation, the ratio filtrate/ethanol and the refrigeration time have been classified statistically negligible (Table 10). Here, the steeping time was the most significant parameter while contributing to 84.24% in the variation of mucilage contents (Fig. 4). It's followed by the ratio vegetal/water (79.02%) and the heating time (48.34%). Experimental design permitted to identify 3 technological parameters that intervene significantly in the extraction. To the level of the kernels, a previous délipidation is obligatory before all other manipulations. The kernelss of *I. gabonensis* are very rich in fat matter (Kehlenbeck *et al*., 2013; Matos *et al*., 2009; Kouamé and Gnahoua, 2008). This fat matter is composed mainly of saturated fatty acids (Womeni *et al*., 2006; Ngondi *et al*., 2005) and could interfere with the complex polysaccharidical nature of mucilages (Sepúlveda *et al*., 2007; Sáenz *et al*., 2004). Mucilages extraction of the leaves showed that délipidation is a very negligible factors, this fact could explain itself by the weak contents of the leaves in fat matters (Agbo, 2004; Gopalan *et al*., 2007; Varmudy, 2011; Zoro *et al*., 2013). We can deduct some that it is not necessary to make a delipidation during mucilages extraction of plant material which has weak content in lipids (Woolfe *et al*., 1977; Ahad *et al*., 2001; Malaviya, 2011; Ngwuluka *et al*., 2014). Several parts of plants (leaves, roots, fruits and calyx) don't require a previous delipidation before mucilages extraction but the ratio vegetal/water is a significant factor to take in account (Clarke *et al*., 1979; Muazu *et al*., 2014; Gupta and Mukherjee, 2003). Otherwise, the steeping time is also important for an efficient extraction (Tangri, 2014; Biswal *et al*., 2014). As for the heating time, several works showed its interest in the process of extraction. However this length stays in the majority of the cases below one hour (Nenonene *et al*., 2009; Atcholi *et al*., 2015; Rajendra and Shende, 2015). The results of experimental analysis show that mucilages extraction of *Irvingia* kernels and of *C olitorius* leaves is encouraged by the delipidation, the ratio vegetal/water, the steeping time and the heating time.

To the level of kernels, the optimal process is determined by the following factors:

- Delipidation: yes
- Ratio vegetal/water: 1/50
- Steeping time: 24 h

To the level of the leaves, it is about:

- Ratio vegetal/water: 1/50
- Steeping time: 24 h
- Heating time: 1 h

Validation of full factorial design optimization of mucilages extraction

The results of full factorial design permitted to determine the optimal conditions of mucilage extraction of mucilaginous food plants. All models have been established with a satisfactory coefficient of determination R^2 ranging from 0.99 to 1; which means a close agreement between the experimental results and those predicted by the models. The test of validation of mathematical model realized, with predicted and experimental answers of mucilages contents, gives the results registered respectively in the Table 11 and 12. The experimental values of mucilage contents in the kernels and leaves are respectively of 56.34±0.42% and 25.81±0.39%. These values are appreciably equal to those predicted by the mathematical models. Also statistical analysis doesn't reveal any significant difference to the risk 5% among experimental and predicted results. The full factorial design is valid to predict mucilages contents of the kernels and the leaves.

Conclusion

The study realized allowed us to value the influence of the operative conditions on mucilage yields. Study made on the kernels and the leaves of the edible parts of the mucilaginous plants with experimental design. This design permitted to put in evidence the most significant factors. To the level of the kernels, the délipidation, the ratio vegetal/water and the steeping time are significant factors. As for the leaves, the ratio vegetal/water, the steeping time and the heating time are retained. The mathematical models showed from the factors predicted some answers appreciably equal to the experimental answers. We can say that optimization achieved in the present study is reliable.

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