SENSORIAL ASSESSMENT OF DOUGH FROM COMPOSITE FLOURS BLENDED WITH CASSAVA AND AFRICAN OIL PALM HEART AT DIFFERENTLEVELS OF HYDRATION

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Abstract
The current research aims to assess organoleptic properties of doughs obtained from composite flours blended with cassava and oil palm heart at 10, 20 and 30 % and under hydration conditions. The composite flours were coded Cf10HP (which contained 90 % of cassava and 10 % of oil palm heart), Cf20HP (which contained 80 % of cassava and 20 % of oil palm heart) and Cf30HP (which contained 70 % of cassava and 30 % of oil palm heart). Doughs were obtained by adding water in proportions of 1/4, 1/2 and 3/4 with respect to composite flours weight. Then, the organoleptic properties of the resulted doughs were evaluated. The results showed that water amount in doughs increased when oil palm heart flour increased too in composite flours. Doughs coded Cf30HP1/2 4 (which contained 30 % of oil palm heart flour and water proportion of 1/2) and Cf30HP3/4 (which contained 30 % of oil palm heart flour and water proportion of 3/4) showed the highest volume and normal hardness. In addition, these doughs displayed smoothing and tights characters. They were also more extensible than the other doughs. We could noticed that, by increasing oil palm heart level to 30 % in the composite flour and adding enough amount of water, we obtained dough with best properties for pastry product.

Keywords:cassava flour, oil palm heart flour, composite flours, dough, organoleptic properties.

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1. INTRODUCTION

Cassava roots are important sources of calories and household cash income in West Africa. These roots are thus the staple food for people in the South, West and Central of Côte d'Ivoire (N'Zué et al., 2013)[1]. In Côte d'Ivoire, cassava roots are transformed locally into more than 20 products such as *attiéké, placali, foutou, gari*, starch, flour, bread, cake and many others (Ezedinma, 2017)[2]. Among products obtained from cassava, flour is increasingly oriented in the food industry where it can be used in the elaboration of products such as thickeners, dehydrated soups, noodles, extruded products, seasonings, breaded, baby food, sweets and processed meat (Balagopalan et al., 1988,Fernández et al.,1992,Day et la., 1996, Adebayo et al., 2010 and Aristizábal et al., 2017)[3,4,5,6,7]. Unfortunately, some products derived from cassava flour have lower technological and sensorial qualities than those prepared with another flours (Alvarenga et al., 2011)[8]. In order to give a place of choice to cassava flour in the food industry, incorporation tests with other ingredients are conducted by many researchers (Akubor and Ukwuru, 2003,Tharise et al., 2014,Anyobodeh et al., 2016 andChakrabarti et al., 2017)[9,10,11,12].
The heart of the oil palm is a by-product that is used for human nutrition in many countries (Blanc-Pamard, 1980, Tabora et al., 1993 and Brou et al.,2018)[13,14,15]. Its incorporation into flour for technological purposes is observed in Southeast Asia where indigenous populations transform it into starch for use in mixed bread making (Tabora et al., 1993)[14]. The heart of the palm trees is an excellent source of vitamin C and a potential source of vitamins A, B1, B2, B3, B6 and K (Abd Hamid et al., 2013and Salvi and Katewa, 2014)[16,17]. Minerals such as potassium, calcium, magnesium and phosphorus are found in significant quantities (Brou et al.,2018)[15]. In addition, palm heart has a strong antioxidant activity with a

predominance of polyphenols and flavonoids (Trabzuni et al., 2014)[18]. Otherwise, oil palm heart is moderately rich in protein (10.7±0.66 - 13.12±0.69 % in dry weight) according to Brou et al. (2018)[15] and all essential amino acids are present in the heart of the palms (Tabora et al., 1993)[14]. Hearts of palm are also excellent source of dietary fiber (Trabzuni et al., 2014)[18].

This study aimed to provide information about the behaviour of doughs in order to promote the use of composite flours obtained from cassava and oil palm heart in food industries.

2. MATERIAL AND METHODS

The material used in this study was consisted of composite flours blended with cassava and oil palm heart. The heart of African oil palm (Elaeïsguineensis Jacq.) were isolated from the crown of the 20 years old palm stipes. Then, cassava tuberous roots (ManhiotesculentaCRANTZ), including the sweet variety "Bonoua 2" were purchased on the local market of Abidjan (Côte d'Ivoire). These raw materials were transformed into powder by the Laboratory of Biocatalysis and Bioprocesses of the Nangui Abrogoua University (Abidjan / Côte d'Ivoire).The codes of the composite flours and its definitions are displayed in the Table 1.In addition, the fine salt (NaCl; 99 %) is from SAGID-Côte d'Ivoire and the baker's yeastInstaferm (17.64 OZ) is made in EU.

Table 1: Samples of cassava flour and composite flours

Flour and composite flours	Definition
Cf	cassava flour
Cf10HP	cassava flour blended with 10 % of the oil palm heart
Cf20HP	cassava flour blended with 20 % of the oil palm heart
Cf30HP	cassava flour blended with 30 % of the oil palm heart

2.1.1 Determination of dough wettability

Wettability rate in the composite doughs blended with cassava and oil palm heart flours were determined through preliminary trials (Pasqualone et al., 2010)[19]. The criteria used to determine the lower limit were the firmness of the dough and the absence of crumbling during manual kneading. Concerning the upper limit, the stickiness of the dough and the difficulty in handling were the criteria fixed.

Exactly 30 g of flour sample were mixed with 1 mL of distilled water. The hydrated mixture was kneaded for 30 seconds. The operation was repeated with the same amount of water and the same shearing time until the fixed characteristics were obtained. The amount of added water (Wa) at the end of the kneading was estimated in milligrams of water. The total water content in the dough was calculated using Equation (1).

2.1.2 Doughs preparation

For doughs preparation, about 100 g of composite flours, contained in a stainless steel basin, were mixed with 2 % of dry yeast and sodium chloride. After addition of the required amount of water, everything was well mixed using a brand automatic mixer (R2723, Hei-TORQUE, Schwabach, Germany). The mixing operation was carried out in two equal periods of 15 min each, separated by a rest time of 5 min.

2.2 Swelling kinetics of doughs from composite flours

The evaluation of the swelling of the doughs of the cassava / heart of the oil palm and yellow maize / oil palm heart flours was done according to the method described byRoussel and Chiron (2002)[20]. The sprouting controller was a small cylindrical vessel of about 120 ml graduated, with a lid drilled in the center to let pass and guide a small rod having at its base a disc to keep the surface of the dough well horizontal during its lifting. The disc which slides as the fermentation progresses acts as an indicator of the level of emergence of the dough. A mass of 25 g of dough was flattened at the bottom of the push controller. The whole was placed in an oven at 35°C and the volume of the dough was monitored for one hour. The expansion volume of the dough was given by the Equation (2).

2.3 Sensory evaluation of doughs from composite flours

The evaluation of the dough profile was carried out by a descriptive and quantitative test according to standard NFV 03-716 (Roussel et al., 2010)[21].The panel consisted of 19 people including 11 men and 8 women which age ranged 28 to 40 years old. The panelists are professionals in the preparation of bakery products residing in the town of Cocody (Abidjan). The selection of panelists was based on their knowledge of the sensory profile of baked goods. The test lasted two days and took place in two sessions. The first session, lasting 1 hour and 30 minutes, was used to familiarize subjects with each of the selected terms of the sensory glossary (definition and procedure). The second session was devoted to subject evaluation; it lasted 45 min.

During the assessment session, each subject received a sample of dough on a disposable plastic plate, marked with the code. The subjects had systematically at their disposal measuring instruments (graduated rule, chronometer). Ratings were assigned from the rating scale varying from deficiency to excess (smoothness, stickiness, hardness, extensibility and elasticity) of the dough (Table 2). The sensory response demanded by each subject was the qualitative aspect that makes it possible to identify the perception and describe it, and then the quantitative aspect that corresponds to the perceived intensity. The hedonic aspect was excluded in this part of our study.

The quality descriptors used (Table 3) to describe doughs were taken from the terminology glossary applied to French breads proposed byRoussel et al. (2010)[21].

Mc (%) = [(M / 100) × Ws + Wa] / [MF + (Ws × [NaCl] / 100) + (Ws × [yeasts] / 100) + Wa] (1)

Mc = moisture content (%),Wa = quantity (mg) of added water, M = moisture (%) of the formula, [NaCl] = concentration (%) of sodium chloride, Ws = sample weight (g), [yeast] = concentration (%) of the yeast

$$S (\%) = (Vf - Vi) \times 100 / Vi \quad (2)$$

S = swelling of the dough (%); Vi = volume before fermentation (mL); Vf = volume (mL) of the fermented dough at time t

Table 2: Doughs judgment and marks in terms of descriptor intensities
Source:Roussel et al. (2010)

	Fall in intensity			*Rise in intensity*			
Descriptorintensities	**Very Marked**	**Marked**	**Little marked**	Normal	**Little marked**	**Marked**	**Very marked**
Jugement	Very insufficient	Insufficient	Little insufficient	**Normal**	Little excessive	Excessive	Very excessive
Scaleanchors	1	4	7	**10**	7	4	1

Table 3: Descriptive terms used for sensory profiling of the dough samples

Descriptors	**Definition**	**Operating mode**
Smoothing Character	A surface appearance that describes the homogeneous, even or smooth character of the dough at the end of kneading. The smoothing was appreciated from the themes: smooth (10), ribbed (7), cracked (4) and torn (1)	At the observation: -the "ribbed" appearance (presence of protruding threads on the surface of the dough); -the appearance "cracked" (cracked appearance or presence of cracks on the surface of the dough); -the "torn" appearance (no smoothing or continuous structure).
Tightscharacter	Level of adhesion between two identical or	It is appreciated by touching resistance when

	different surfaces (the back of the hand and the dough).	separating the two surfaces or by quantifying the amount of material adhering to the surfaces. The measurement must be made by contact with the back of the folded hand, with constant contact time, and with a constant tearing speed.
Hardness	Resistance to deformation.	Appreciated by the level of resistance bypressing the finger into the dough at the same rate of loading (about 2 to 5 cm / s).
Extensibility	Ability of a body to deform (elongation of the dough), under the action of mechanical stresses, to a point of rupture (tearing), according to a direction or a plane perpendicular to the direction of stress.	the extensibility is measured, between 3 and 4 min after the stop of the kneading, by a continuous stretching (vertical uniform rectilinear movement) of the dough until its rupture. Excess corresponds to elongation levels greater than 20 cm and insufficiency to levels < 10 cm; the absence of elongation corresponding to a "brittle" dough was noted 1.
Elasticity	The ability of a dough to return to its original shape after instant stretching.	Measure at constant deformation and at a low level of deformation = 5 cm. A quick return was judged "in excess" and a slow return to "normal". The lack of return wasdeemed "deficient" and rated 1.

Source:Roussel et al. (2010)

3. RESULTS AND DISCUSSION

3.1 Evolution of water content in the composite doughs

The results of the amount of water required for good hydration of doughs obtained from the composite flours blended with cassava and oil palm heart are summarized in Table 4. We observed that the amount of water added in the doughs increased significantly ($p < 0.05$) as far as oil palm heart flour was high in the composite flour. It ranged between 57.5 – 82.7 % in only cassava dough and between 97.8 – 129.9 % in dough obtained from composite flour blended with 30 % of oil palm heart. This enhances of water amount in the dough with high content of oil palm heart flour were due the increasing of protein content in composite flour to the detriment of starch. For Stefanet al. (2015)[22], the protein substances absorb the largest amount of water used in the mixing process, while the starch absorb a smaller amount of water.

3.2 Swelling capacity of doughs obtained from composite flours

Considering the 1/4 hydration level, there was a very slow volume of all the composite doughs whatever the amount of oil palm heart flour added in composite flours. This observation remained the same throughout the incubation period with maximum levels of relatively low swelling. These levels were 16 %, 18 %, 33 % and 39 % respectively for the doughs obtained from Cf, Cf10HP, Cf20HP and Cf30HP(Figure 1). ForLuchian et al.,(2011)[23], too little water in dough will lead to a too underdeveloped volume.

When hydration level grows for 1/2, the doughs volume increased as far as oil palm heart amount increased into the composite flours. The maximum volume was achieved after 30 minutes of incubation for the doughs obtained from composite flour Cf30HP with values of 54 % (Figure 2). Previous modification of dough is observed when added water proportion of 3/4 (Figure 3). ForHwang and Gunasekaran(2001),[24] the hydration level of the dough positively influenced its specific volume. It is thus important to produce a dough with an optimum water level. Beyond the maximum point of swelling, a slight decrease in volume was observed with doughs. This could be attributed to the quality and quantity of cassava proteins, especially to the inability of the proteins in this flour to form a network of covalent bonds that can retain CO_2 for a long time (Miyazaki et al., 2005 and Pasqualone et al., 2010)[25, 19].

Table 4: Water content of doughs obtained from composite flours

Flour and composite flours	Hydration levels (%)				
	Minimum	1/4	1/2	3/4	Maximum
Cf	57.5 ± 0.0^{d}	63.8 ± 0.0^{d}	70.1 ± 0.0^{d}	76.4 ± 0.0^{d}	82.7 ± 0.0^{d}
Cf10HP	62.6 ± 0.0^{c}	70.6 ± 0.0^{c}	78.5 ± 0.0^{c}	86.4 ± 0.0^{c}	94.3 ± 0.0^{c}
Cf20HP	81.4 ± 0.0^{b}	90.9 ± 0.0^{b}	100.5 ± 0.0^{b}	110.0 ± 0.0^{b}	119.6 ± 0.0^{b}
Cf30HP	97.8 ± 0.0^{a}	105.8 ± 0.0^{a}	113.8 ± 0.0^{a}	121.8 ± 0.0^{a}	129.9 ± 0.0^{a}

Mean ± standard deviation and number of trials = 3
On the same column, means ± standard deviations with different letters were significantly different at P < 0.05 according to the Duncan test.

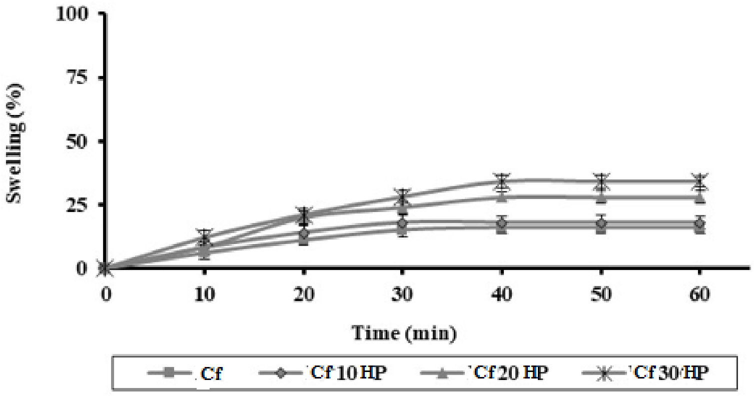

Figure 1 Dough swelling with respect to 1/4 hydration levels

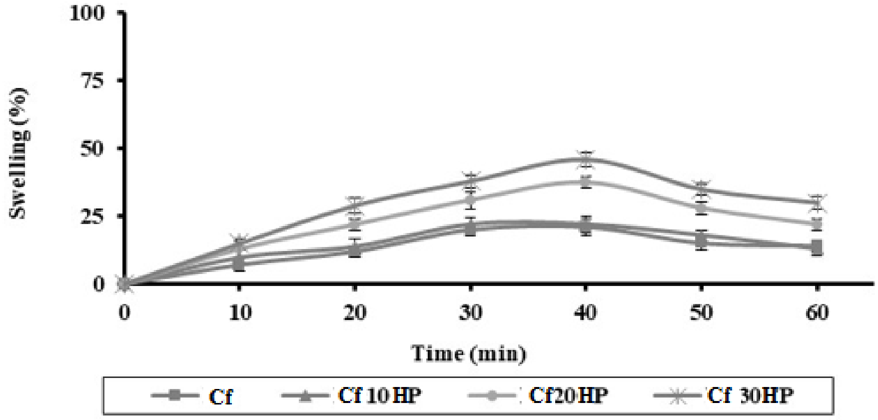

Figure 2 Dough swelling with respect to 1/2 hydration levels

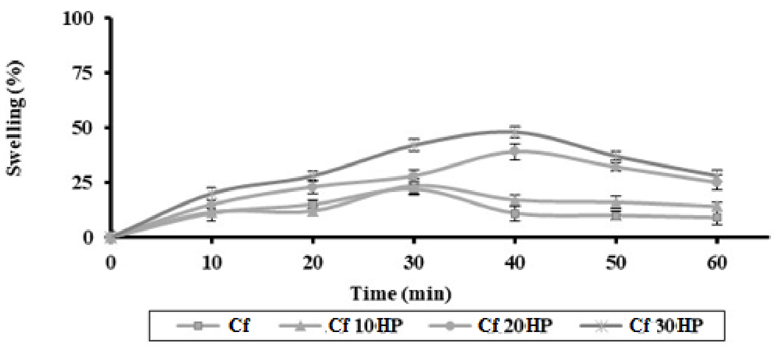

Figure 3 Dough swelling with respect to 3/4 hydration levels

3.3 Organoleptic behavior of the composite doughs

The results of the sensory analysis of the doughs obtained from composite flours blended with cassava and oil palm heart are given in Table 5. Results showed that by adding water in proportion of 1/4 did no significant influence ($p > 0.05$) doughs' organoleptic properties. Indeed, these doughs recorded a low score (1) for all organoleptic criteria. They have been characterized by a lack of smoothing, extensibility and elasticity. With a torn appearance, these doughs were tough and did not show a sticky character. At 1/2 hydration level, the doughs from single cassava flours (Cf) and composite flours (Cf10HP and Cf20HP) improved in terms of hardness and extensibility (with a score of 4 and 7 respectively). These doughs were therefore less hard compared to the previous ones. At this same hydration level, the dough ofCf30HP flour presented a ribbed, sticky appearance and normal hardness. This dough was not elastic and less extensible. In addition, the sensory characteristics recorded with the doughs contained 1/2 and 3/4 proportions of water were similar. According toLuchian et al. (2011)[23], organoleptic properties of the dough increase up to certain values of water content, corresponding of maximum water absorption of the proteins. Then, optimum consistency is obtained when the dough contains enough water to swelling flour components such as proteins.

3.4 Classification of composite doughs base on theirs organoleptic characteristics

Figure 4 shows the organoleptic characteristics used to discriminate the formulas based on simple flour and composite flours. The first two axes mainly explain the variances (83.6 %) between the doughs and organoleptic properties. Axis 1 explained (71.0 %) and axis 2 represented (12.6 %). The principal components analysis makes it possible to divide the doughs into three classes. Class I, positively correlated with axis 1, consisted of doughs obtained from composite flours containing 30 % of oil palm heart and water proportions of 1/2 and 3/4 (Cf30HP1/2 and Cf30HP3/4). The doughs of this class showed tights and smoothing characters. They were also more extensible and less hard. An intermediate class II enclosed doughs such as Cf20HP1/2, Cf20HP3/4 and Cf30HP1/4. Such doughs explained poor elasticity character because of lack of water or insufficient amount of oil palm heart in composite flours. Hwang and Gunasekaran (2001)[24]mentioned that elasticity property of the dough increase up to certain values of water content, corresponding of maximum swelling of the proteins. Class III, negatively correlated with axis 1, is composed of doughs prepared with only cassava flour samples (Cf1/4, Cf1/2 and Cf3/4) or composite flours blended with 10 % of oil palm heart (Cf10HP1/4, Cf10HP1/2 and Cf10HP3/4). The lack of proteins and water in such samples conferred to them poor organoleptic properties. For Stefan et al. (2015)[22], in the dough formation process, the flour and the water are the basic components.

Table 5: Composite doughs sensory characteristics with respect to hydration levels

Doughs from composite flours	Sensorial descriptors				
	Hardness	Smoothing character	Tights character	Elasticity	Extensibility
Cf1/4	1.0±0.0^{d}	1.0±0.0^{b}	1.0±0.0^{b}	1.0±0.0^{a}	1.0±0.0^{b}
Cf10HP1/4	1.0±0.0^{d}	1.0±0.0^{b}	1.0±0.0^{b}	1.0±0.0^{a}	1.0±0.0^{b}
Cf20HP1/4	1.0±0.0^{d}	1.0±0.0^{b}	1.0±0.0^{b}	1.0±0.0^{a}	1.0±0.0^{b}
Cf30HP1/4	1.0±0.0^{d}	1.0±0.0^{b}	1.0±0.0^{b}	1.0±0.0^{a}	1.0±0.0^{b}

Cf1/2	4.0±0.0^{c}	1.0±0.0^{b}	1.0±0.0^{b}	1.0±0.0^{a}	1.0±0.0^{b}
Cf10HP1/2	4.0±0.0^{c}	1.0±0.0^{b}	1.0±0.0^{b}	1.0±0.0^{a}	1.0±0.0^{b}
Cf20HP1/2	7.0±0.0^{b}	4.0±0.0^{a}	10.0±0.0^{a}	1.0±0.0^{a}	4.0±0.0^{a}
Cf30HP1/2	10.0±0.0^{a}	4.0±0.0^{a}	10.0±0.0^{a}	1.0±0.0^{a}	4.0±0.0^{a}
Cf3/4	4.0±0.0^{c}	1.0±0.0^{b}	1.0±0.0^{b}	1.0±0.0^{a}	1.0±0.0^{b}
Cf10HP3/4	4.0±0.0^{c}	1.0±0.0^{b}	1.0±0.0^{b}	1.0±0.0^{a}	1.0±0.0^{b}
Cf20HP3/4	7.0±0.0^{b}	4.0±0.0^{a}	10.0±0.0^{a}	1.0±0.0^{a}	4.0±0.0^{a}
Cf30HP3/4	10.0±0.0a	4.0±0.0a	10.0±0.0a	1.0±0.0a	4.0±0.0a

Mean ± standard deviation and number of trials = 19
On the same line, means ± standard deviations with different letters were significantly different at P <0.05 according to the Duncan test

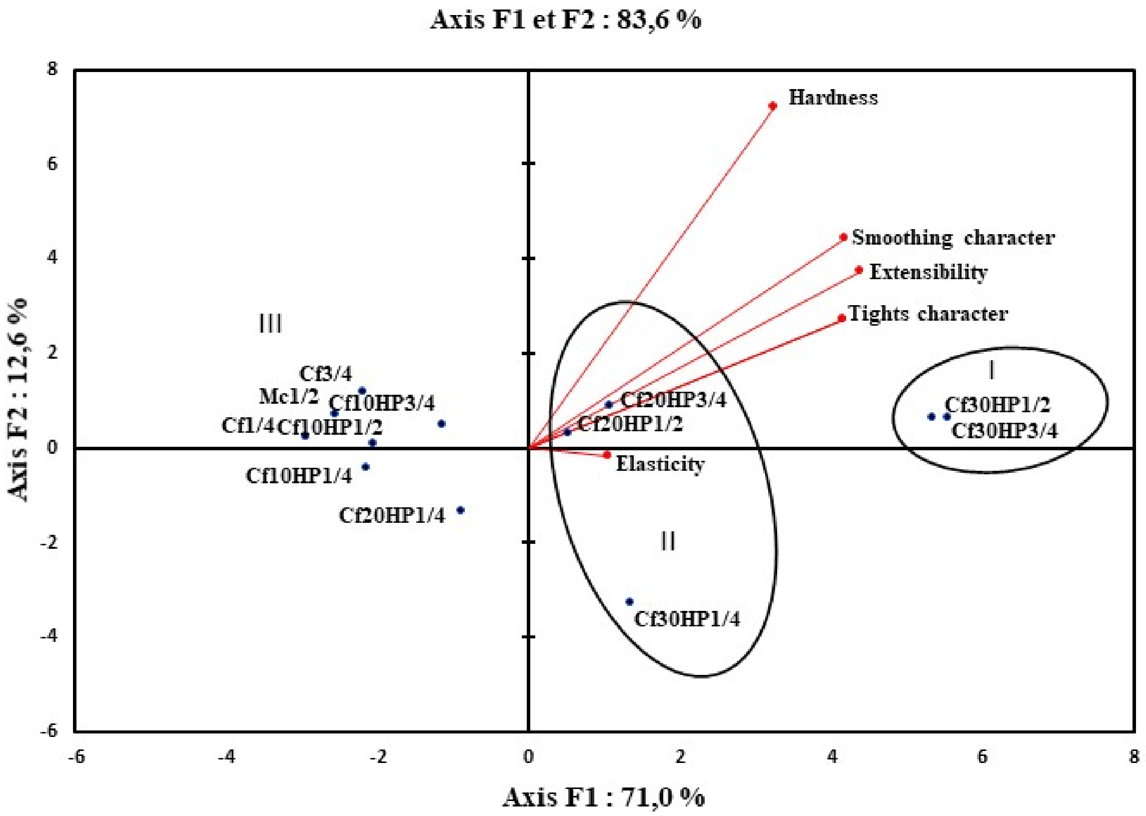

Figure4 Classification with respect to organoleptic properties of the doughs obtained from composite flours blended with cassava and oil palm heart at different levels of hydration

4. CONCLUSIONS

In this study, we observed that the quantity of added water increased as far as oil palm heart flours increased too in composite flours. Thus, by adding enough amount of water (1/2 and 3/4 levels), the doughs obtained from composite flours Cf20HP and Cf30HPbecame more voluminous. However, insufficient amount of water (1/4 level) has a negative influence on the doughsvolume. Doughs obtained from composite flour Cf30HP with added 1/2 and 3/4 of water displayed best organoleptic characters; they were more smooth, extensible, tights and less hard.

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