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Mechanical Semolining of Fermented Cassava Dough on Physicochemical and Sensory Characterises of Produced Attiéké

Pierre Martial Thierry Akely[1], Charlemagne Nindjin[2], Georges Amani[2]
[1] Ecole Normale Supérieure, 08 BP 10 Abidjan 08
[2] Nangui Abrogoua University, 02 BP 801 Abidjan 02, Cote d'Ivoire
akely_pierre@yahoo.fr

Abstract

Semolining for attiéké production is traditionally manufactured physically by hand in wooden device. The end cooked attiéké obtained is subjected to low sensory and physicochemical qualities. For avoiding its variability and enhancing high quality end product, influence of mechanical semolining of fermented cassava dough during attiéké manufactured is carried out in this study for cottage industry; industrial and household can all benefits. Experimentally 4500 g of cassava are being prepared into cassava mash which is mechanically semolined in triplicate. During the process, 25 angle tilts deviation of the machine (SI) are being investigated. For each angle tilt experienced cassava dough is differently study according to the water content, inocula level adjunction and fermentation time. Samples were collected for total sugar content, cyanide content, starch content, total solid content, and grain size physical chemical and sensory analysis. As compared to traditional control, the semolina grain sizes (1.52±0.04 and 1.82±0.02 mm) are attained from 26.3 to 31.6 angle tilt intervals. Consequently when cassava mash run about 52 % of the moister content, 10 or 12% amount of inocula loaded and 12 or 24 hrs of fermenting paste. Interestingly at these the optimal semolina size grain is 1.32±0.02 especially at 31° angle tilt deviation, and comparatively fitted to traditional grain sizes taken as a control. Singularly when cassava dough is left for fermenting 12 or 24 hours, the semolina grain size collapsed between 1.12±0.13 and 1.35±0.07 diameters. But when it loaded with 10 to 12% amount the semolina grain sizes get from 1.19 ± 0.06 to 1.27 ± 0.04. Finally the attiéké obtain after mechanical semolining is evaluated having very good sensory quality compared to the traditional attiéké control as regards grain sizes and homogeneity even for fresh or cooked semolina one. In conclusion, mechanical semolining is achieved in condition that cassava dough was loaded at 10% amount of inoculation and, left to ferment 12 hours. A final semolina end product could be obtained when cassava mash is moisten at 52% of solid content and semolined at 31° angle tilt deviation. Semolinor technology innovation in attiéké production could enhance attiéké texture and safety qualities so that household and industry can all benefits

Keywords: Cassava IAC, Semolina, Sensory and Organoleptic Qualities, Semolinor (SI), Attiéké.

Introduction

Attiéké a starchy-couscous dish is derived from fermented cassava dough processing and, most importantly produced in Ivoirian household foodstuffs. This staple food stands for its high consumption in African urban areas (**Kouassi *et al*., 2008**). Consequently it increasingly spreads from its origin of Cote d'Ivoire to Europe, America and Asia due to black African-diasporas immigration (**Kakou, 2000**). In Cote d'Ivoire attiéké plays a large part in household livestock as regards to its numerous and various utilisations (**Bendech *et al.*, 2000**). As respect to that importance attiéké is mentioned representing 5% food expenditure and 20.5% calories diet daily intake for consumers. The biggest producers and consumers are well-knew to be southern region's inhabitants of Cote d'Ivoire. For attiéké is major source of activity incoming generator especially for female. Thus production of attiéké is approximately estimated around 18 965 to 40 000 tons whereas consumption per inhabitants is varying between 28 and 30 kg annually (**Trèche, 1995; Giraud *et al.*, 1995; FAO, 2001**). Production of attiéké seems to be well integrated likewise root tuber (i.e. cassava and yam), cereal (i.e. rice, maize and sorghum) out of the most part Ivorian market as well as West African region (**Amani et Kamenan, 2003; FAO, 2004; FAO, 2006**). This food is still informally home-grown even though its importance in Ivorian foodstuffs. Preparation proficiency is strictly based onto traditional-empirical experience but none on rational modern food processing experience (**Essers *et al.*,**

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1993; Fortin *et al.*, 1998; Mosso *et al.*, 2000). Indeed attiéké is mostly processed after the unit operations comprising peeling, grating, fermenting, pressing, crumbling, sieving, semolining, drying, air winding, and cooking very often described elsewhere (**Aboua, 1998 ; Sotomey *et al.*, 2001; Djeni *et al.*, 2008**). These unit operations are holding traditionally so that variation may occurs due to its processing complexity and difficulty. According to area of production attiéké is sold in many form and kind namely "attiéké garba", " attiéké abgodjama", " dehydrated attiéké ", "attiéké-gari", "humid attiéké" or "akyeke- akyeke" in other Africa region. The home-made processing of attiéké therefore is to female a cause of painful, intensive physical hard working activities that are gruelling for women performers. Furthermore for every unit operation handling may arise with unhygienic and microbial risks intoxication as well as food alteration and deterioration. Pathogenic microorganism and unfavourable cyanogenic glucosides (-CN) appearances bound up with mishandling of unit operations that influence the sensory quality of attiéké. Anyway semolining of cassava mash is traditionally processed outdoors and manually along with decay wooden utensils that lead to inconsistent product quality. Obviously the end-product gets contamination from uncontrolled working environment and unhygienic process condition. Additionally semolining processing takes more than one working-hour depending of operator, its ability and experience. Semolining time length is depending on the residual water content of mash and the working force or intensity released while processing into semolina. And so semolina quality texture is interdependent on inoculums level incorporation, fermentation time, water content amount of final pressing mash. Attiéké quality can in fact be improved by mastering all unit operations fundamentally the fermentation, dewatering or pressing and semolining steps by large extent. To perform a better control of semolining a newly Semolinor machine (SSI) has been integrated in the process of attiéké manufacturing and parameters that influence semolining step have been studied.

The objective of this work is to investigate on the “influence of Mechanical Semolining of Fermented Cassava Dough on Physicochemical and Sensory Characterises of Produced Attiéké”. Specifically it aims firstly to find out the optimal water content in which cassava mash can ideally be processed into semolina. Secondly to determine the requiring angle of tilt deviation for obtaining homogeneous semolina, and finally to determine semolina ideal size for improving semolina texture quality and yield production. As a working hypothesis do the fermentation, dewatering and semolining interdependent, and consequently influencing attiéké physicochemical and sensory characteristics. Semolining processing could be controlled for an acceptable attiéké quality?

Material and methods

Cassava root

Suitable mature and fresh cassava root from Improved African Cassava (IAC, *Manihot Esculenta CRANTZ,* UNA) variety were used in these experiments. The cassava roots of 12 months age, weighed between 0.5 and 1 kg with maximum starch level from 80% to 90% were used for pressing, semolining, and the end-product (i.e. attiéké) for sensory evaluation.

Experimental procedure for deliquoring

Procedure for deliquoring consisted in determining relationship between optimal pressing force and the water released for bringing the moisture content to 52%, for 4500 g of pealed and grated IAC cassava. Previously force intensity is measured by mean of dynamometric sensor after cabrating with a universal press (Wolpert Tyz, kN, germany). Consequently the resulted pressure equalled to 1.55 ± 0.30 kN. It may be noted that force (F) measured experimentally depends on the working length (ΔL) of the screw press. And it is measured in “thread of screw” or metre unit. K represents the elasticity coefficient in *N/m*. If *N/m is* 0.3 *cm* then k collapsed to 0.03 N/thread of screw for 10 N/m. It may be noted that F was measured experimentally and its value was also determinated from dynometric sensor, and the two values matched within 1%: $F = k.\Delta L$ (1). Finally pressure (P) was deducted from the (F) force applied and contact surface area (S): $P = F/S$ (2). Experimental results relating to pressing were replicated six times to determine mean values and errors.

Procedures for semolining

The mash obtained after pressing at a force of 1.55 ± 0.30 kN is successively semolined according to semolinor’s angle of tilts, moisture content necessary for producing best attiéké. Results of every angle of tilt are calculated following equation stated in table I below.

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Tableau I: Corresponding determined Semolinor angle of tilt

Length (cm) X_i	**Sine α** **Sin α =45+xi/97**	**Cosine α** **Cos α =91/97**	**Tangent α** **Tan α =45+xi/91**	**Angle of tilts in degree °α**
0	0.46	0.93	0.49	26.3
5	0.51	0.93	0.54	28.7
10	0.56	0.93	0.60	31.1
15	0.61	0.93	0.65	33.3
20	0.67	0.93	0.71	35.5
25	0.72	0.93	0.76	37.5

Subsequently, 4500 g of cassava mash are experimentally semolined following each angle of tilt. Hundred grams of semolinas obtained are then collected and sifted by a granulometer summit (model 1500, Peter Instruments, Hudding, Sweden) in triplicate for determining semolina grains size.

Procedure for sensory evaluation

Attiéké tasters are recruited and selected for constituting a single panel. Formation, recycling and sensory evaluation of panellists are according to **Stone *et al*. (1974)**. Method principle is based on quantitative description of organoleptic property of different kind of semolinas. Panelists' achievement is evaluated by proposed respectability quantitative response scale. Twenty five voluntary of 11 women and 14 men are recruited by mean of a survey questionnaire of **Meilgaard *et al.* (1987)**. Additionally volunteers are tested for their capacity of describing the right semolina by a triangular test comparison (**Giboreau *et al*. 2007**). After that the challenge twelve (12) panellists of 05 women and 7 men are definitively constituted for final sensory test. Experimentally six (06) sample of 100 g fresh and cooked semolina are displayed in porcelain plate and, codified randomly to be tested for their sensory properties. For each attiéké sample tasted, the attributed organoleptic characteristics are evaluated by mean of panelists.

Physicochemical analysis

Different usual analysis were performed on hundred grams of fresh cassava and attiéké samples comprising the determination of granulometry (**AACC, 2000**), total sugar (**Dubois *et al*., 1956),** dry mater (**AOAC, 1999**), cyanide content **(O'Brian *et al*., 1991 ; Essers *et al*., 1993 ; Abban *et al*., 2011**) and starch(**Hassid et Nuefeld, 1964**) in triplicate.

Statistical analysis

Differences between means (ANOVA) from three replications of each sample were performed using significant F-ratios at $p < 0.05$ and the Duncan test (Minitab, 1998). Decisional statistical table was used for the sensory evaluation for confirming differences perception between means at $p < 0.05$ **(Lawless et Heymann, 1998)**.

Results and discussion

Characteristics of fresh and cooked semolina with an optimal force applied

It is noted that 1.58 ± 0.3 *kN* is the optimal force to be applied for obtaining attiéké with sufficient preferred semolina size and quality sensory (figure 1A; B and table II) in contrary to others mechanical force tested. The reason is that force is adequate in term sensory aspects as well as physicochemical characteristics. Attiéké obtained at that pressing force is mostly preferred from women since its look like the traditional one.

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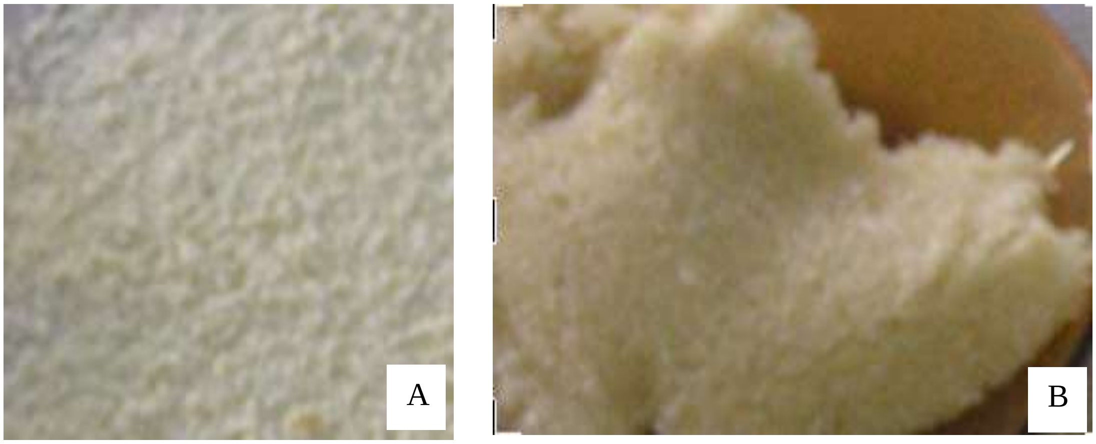

Figure: Cassava semolina (A); Attiéké semolina (B) at 1.55 kN

Effect of force applied on physical chemical characteristics of fresh semolina and cooked semolina are stated in table II below. There is no difference between mean value of cassava semolina and attiéké semolina when compared in line using significant F-ratios at $p < 0.05$.

Table II : Physicochemical characteristics of cassava and attieke semolinas

Force (1.58 ± 0.3*KN*)	**initial Paste**		**cassava semolina**			**attieke semolina**	
Time (min)	**0**	**10**	**15**	**20**	**10**	**15**	**20**
Water	70.0 ± 1.13 a	52.4 ± 1.20 c	52.5 ± 1.02 c	51.8± 1.57c	49.0 ± 1.55 c	47.9 ± 1.38 c	46.4± 2.18c
Starch	83.9 ± 1.32 a	71.1 ± 3.31 c	71.5 ± 2.51 c	71.8± 3.42c	71.7 ± 3.91 c	70.3 ± 3.07 c	70.2± 1.93c
Cyanide	63.7 ± 2.33 a	35.1 ± 1.89 c	35.5 ± 3.04 c	35.0± 2.78c	11.2 ± 1.11 c	11.5 ± 1.41 c	10.8± 1.24c
Sugar	5.73 ± 0.43 a	3.21 ± 0.18 c	3.13 ± 0.09 c	3.36± 0.06c	3.05 ± 0.02 c	3.06 ± 0.05 c	3.08± 0.01c

Mean values (g/L) ± standard deviation from three replications. Value in line following by letters (a, b or c) are significantly different at F-ratios at $p < 0.05$ $p < 0.05$

Preliminary results on pressing force showed that optimal characteristics on ebove table II are to be obtained for processing to semolining. Semolining results are shown that semolina (fresh and cooked) size grains varied differently according to exposed angle tilts even extruded with an optimal monster content of 52%. Therefore it is noted that with a final moister content of 52% and the angle tilt of 31 degree the final grain size are comprising between 1.37 et 1.53 mm. Interestingly semolina diameters obtained are mostly preferred similar to the control. Statistically from 31 to 37 angle of tilts there are not significant different between mean value (table III).

Table III: Semolina grains size variation regarding semolinor's angle of tilts

Angle tilts/ Control		**26°**	**28°**	**31°**	**33°**	**35°**	**37°**
Semolina grain size (mm)	1.36 ± 0.01 a	1.86 ± 0.01 a	1.65 ± 0.02 a	1.53 ± 0.02 a	0.91 ± 0.02 ab	0.66 ± 0.05 ab	0.67 ± 0.05 ab
	1.38 ± 0.01 a	1.84± 0.01 a	1.53± 0.02 a	1.51± 0.02 ab	0.83± 0.02 ab	0.58 ± 0.05b	0.60 ± 0.05 ab
	1.37 ± 0.01 a	1.78± 0.01 a	1.57± 0.02 a	1.55± 0.02 ab	0.86± 0.02 ab	0.64 ± 0.05 ab	0.64 ± 0.05 ab

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Mean values (mm) ± standard deviation from three replications. Value in line following by letters (a, b or c) are significantly different at F-ratios at $p < 0.05$ $p < 0.05$

Anyway semolining with the moister content from 56% to 54% and, 50 to 40%% are not suitable for obtaining preferred semolina grain size similar to the control since grains size are fallen between 3 and 2 mm in the ones hand and, in the others hand between 0.5 et 0.8 mm. Product is rejected for the sensory evaluation.

Sensory evaluation and organoletic characteristics of semolina produced.

Attiéké sample tested is seemed well-known from all volunteers, and consequently 90% of evaluators made thoroughly difference between fresh and cooked semolina's texture tested according to the triangular test shown in table IV below. At that there is no difference between mean values of samples tested whenever regardless the pressing time length (10, 15 and 20 min) for the same given force of 1.55 ± 0.30 kN (table IV).

Table IV: Sensory evaluation of attiéké tested

Time (*min*)	**0**			**10**			**15**			**20**		
Attiéké	D/A	D/C	D/B	A/B	A/C	B/C	A/B	A/C	B/C	A/ B	A/C	B/C
Evaluator	100± 0.01a	100± 0.01b	100± 0.01c	93± 0.01a	97± 0.01b	90± 0.01c	90± 0.01a	97± 0.01b	93± 0.01c	97± 0.01a	93± 0.01b	93± 0.01c

Mean values ± standard deviation in triplicate. A, B, C et D are different attiéké tested. Value in line following by letters (a, b or c) are significantly different at F-ratios at $p < 0.05$ $p < 0.0$

The comparison of Attiéké semolina from different force applied likewise 0.91 *kN*, 2.58 *kN* and 0 *kN* is different notably in term of texture perception due to variable force application. It is recorded some statistical significant difference when compared each others. It is noted that semolina from 1.55 *kN* is interesting even at different time interval of deliquoring since end product is regular likewise the traditional taken as a control. Significant different is not observed according to the triangular test (table IV). Cassava mash at 1.55 *kN is* optimally similar to the control one (traditional attiéké identified) along with a good quality texture. The final mash is further semolined depending of variable angles' tilts for determining the optimal angle at that cassava semolina may be kept standard for mechanical attiéké semolina manufacturing similar to the traditional one. Figure 1 below displays the sensory evaluation profile of different semolina from Semolinor angle of tilt experience

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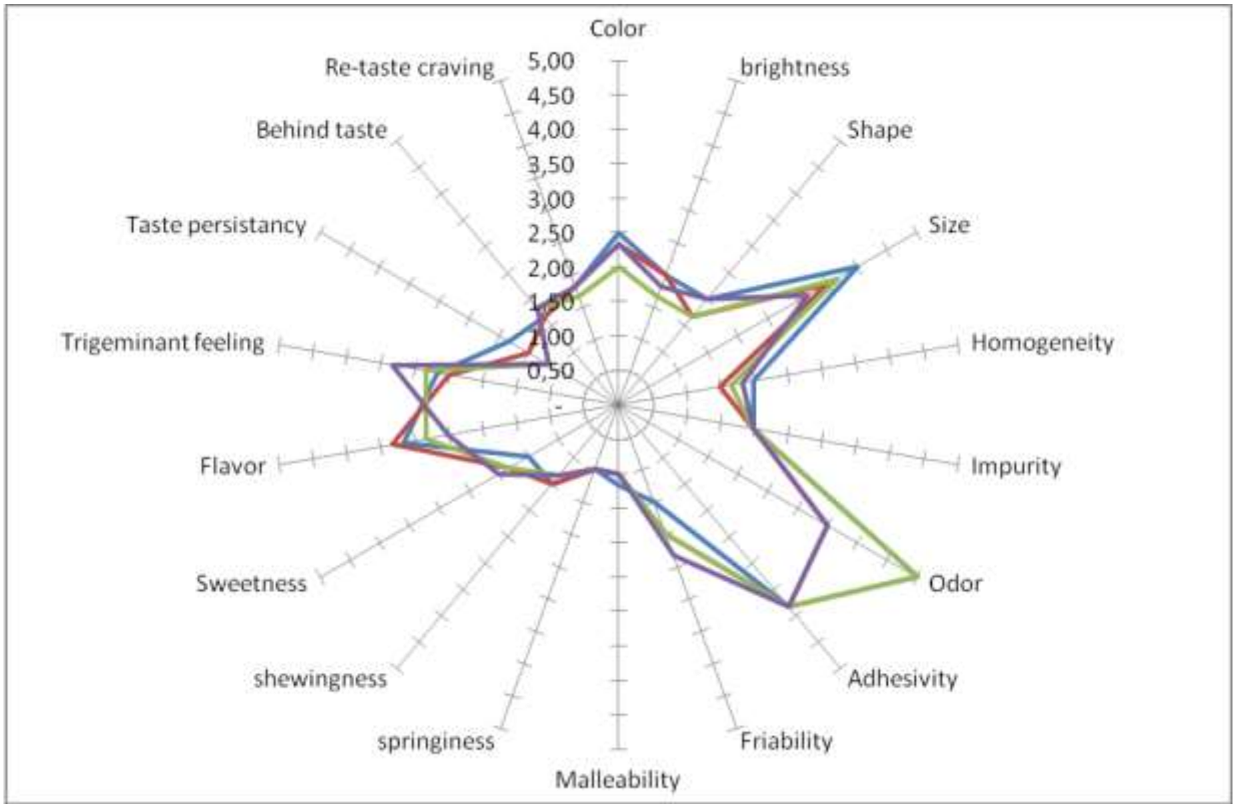

Figure 1 A: Sensory profile of cassava semolinas

S_26: *Control:* **S_28**: *attiéké:* **S_31**: *attiéké*: **S_33**: *attiéké* **33**

Sensory attributes observed of cassava semolina from 26°, 28°, 31° and 33° are seemed matching the control cassava semolina 26°. Indeed sensory attributed for impurity, adhesiveness, malleability, springiness and re-taste craving are projected 2.00; 3.83; 1.00; 1.00 and 1.83 respectively under the control. However, the sensory attribute of grain size (4.00) and homogeneity (2.00) of control semolina 26° are dissimilar except the friability (1.50) once compared to the cassava semolina of different angle of tilts. That may be explained that cassava mash semolined manually is more crumbly or friable than cassava mash semolined mechanically. In General sensory attributes of Colour», «brightness », «grain shapes», «Odour», «shewingness» «flavour» «Persistency of taste» from type of semolina of 26°, 28°, 31° et 33° are respectively are lower than control semolina attributes 26°. Exception is could be noted regarding attributes of sweetness, trigeminent feeling and behind taste. Overall Duncan test analysis did not significantly stated out difference between mean values of attributes except for colour and grain size attributes compared to the semolina control. Figure 2 displays the sensory profile of attiéké semolina from optimal deliquoring of cassava dough at 1.55 kN.

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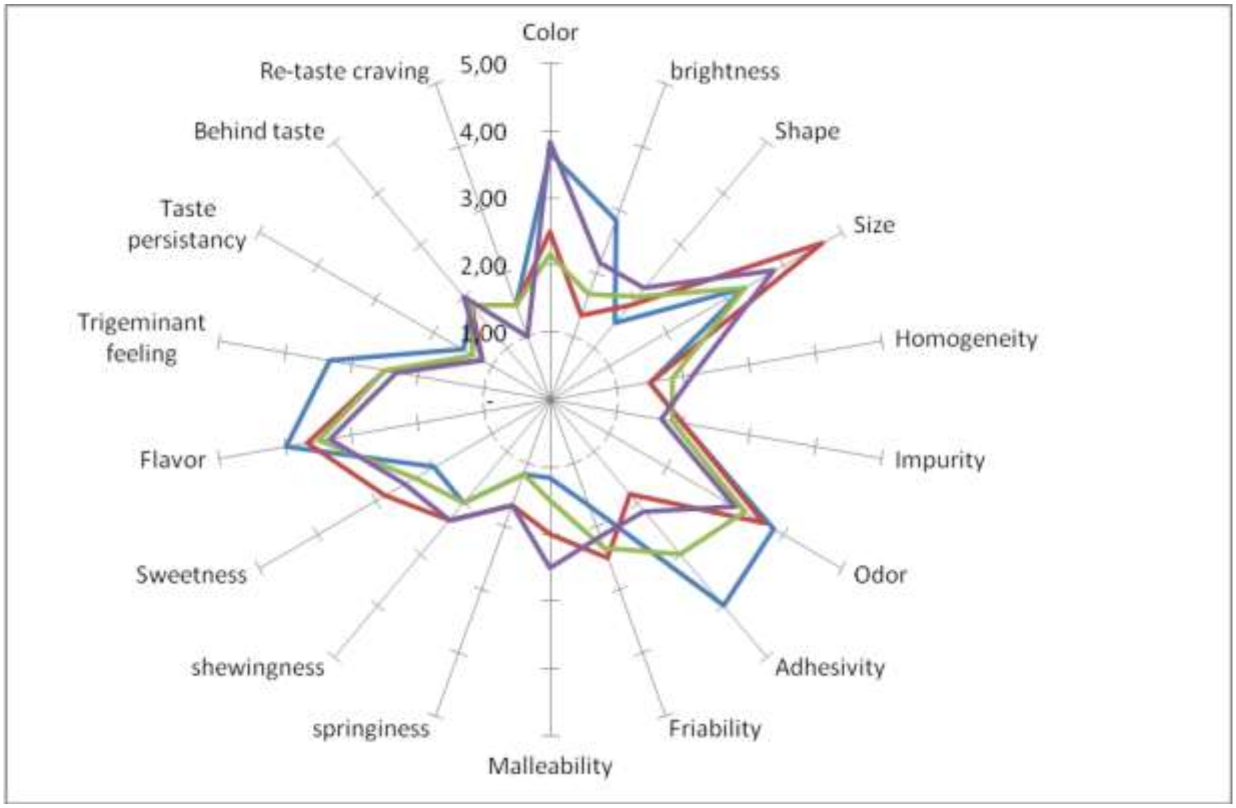

Figure 1 B: Sensory profile of attieke semolinas

S_26: *Control:* **S_28**: *attiéké:* **S_31**: *attiéké*: **S_33**: *attiéké* **33**

Sensory evaluations of attiéké semolina are expressed equal to 1.83 and 1.50 respectively for impurity, behind taste and re-taste craving. Mean values of marks given are not significantly different regarding 26°, 28° and 31°angle of tilts in comparison to control attiéké semolina (26°). Exception is noted regarding attiéké semolina 33 where significant difference is expressed (figure 1 B). That difference means that when semolina grain size became smaller the behind taste is not obvious while chewing. Anyway sensory attributes of 2.83 ; 3.83 ; 4.00 ; 4.00 ; 3.33 et 1.50 are given for the brightness, odour, adhevisity, flavour, trigeminent feeling and paste persistency. These mentioned sensory attributes are under -evaluated and dissimilar to the control respectively excepted colour and friability sensory attributes. The consistency of friability attribute is evidenced by panellists. Generally sensory attributes of grain shape, size, homogeneity, malleability, springiness and shewingness of different semolinas are equivalent or higher than the control semolinas. Therefore exception is noted regarding attributes os impurity and sweetness. And interestingly analysis of Duncun test is not significant at 5% F-ratio.

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Table VI: Results Summary

Cassava species	Cassava variety	Intermediate / end products	Variables of deliquoring and semolining experienced	Tables	Physical chemicals of control product/ characteristics (good quality)	Figures	Optimum couple of deliquoring and semolining obtained
Manioc Esculenta CRANTZ	IAC bitter	Cassava mash	**Pressing force** (kN) 0.91 ; 1.55 ; 2.598 **Length of pressing** (min) 10 ; 15 ; 20, **Angle of tilts (**) 26; 28; 31; 33; 35; .37	**Tableau II**	**- Moisture (DM)** 50-52.5% **Starch** 71.5 **- Acidity** pH 4 **HCN** 35.1 **Sugar** 3.21	**Figure 1A**	**Pressing force** (kN) 1.55 ± 0.3 Angle of tilt (°) 31
Manioc Esculenta CRANTZ	IAC bitter	Attiéké	**Pressing force** (kN) 0.91 ; 1.55 ; 2.58 **Length of pressing** 10 ; 15 ; 20 mn, **Angle of tilts ( )** 26; 28; 31; 33; 35; 37	**Tableau II**	**-Moisture (DM) :** 52-53% **Starch** 71.5 **- Acidity :** pH 4 **HCN** 1.05 **Sugar** 3.05	**Figure 1B**	**Pressing force (kN)** 1.55 ± 0.3 Angle of tilt ( ) 28, 31

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Conclusion

When cassava dough is loaded at 10% inoculation amount and, left to ferment 12 hours and, the cassava dough is dewatered at an optimal pressing force of 1.55 *kN*, the derived product obtained is ideally interesting for attiéké processing along with best semolina texture, physical chemical and sensory characteristics. Cassava and attiéké semolinas are seemed comparable to the control or traditional one. It is noted that mechanical semolining of cassava mash of an optimal moisture content of 52% followed up of an angle of tilt of 31° is found out ideal for attiéké semolining processing. Semolina at 31° is having equal diameters as well as best physical chemical characteristics than the control. In term of sensory evaluation, end-products evaluated are having near characteristics as regarding sensory attribute of grains sizes along with good homogeneity more than the others attributes of products tested. Anyway the pressing force to be considered for

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