Laboratory Standard Operating Procedure

SOP for Sensory Evaluation of Fried Plantain (Aloco)

Biophysical Characterization of Quality Traits, WP2

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ABSTRACT

This standard operating protocol (SOP) describes an objective methodology to assess the relevant sensory attributes of fried plantain (Aloco) by a trained panel. For this study, four contrasting varieties of plantain grown under conventional practices were harvested at the mature green stage and kept ripen at room temperature. Fruits were then sampled at three developmental stages namely yellow with green tips, yellow and yellow with black spots. The plantain pulps were cut into slices of about 2 cm and fried by total immersion in a bath of refined oil, The Aloco products were tested by a trained panel and the corresponding sensory attributes were measured. Sensory attributes considered were appearance (homogeneity of color), smell (frying odor), touch (greasy appearance, sticky between slices), texture in the mouth (firmness, stickiness, chewiness), taste (sweetness, acid taste, saltiness), mouth impression (fat feeling, astringency) and aroma (plantain aroma). The intensity of these sensory attributes was measured on a scale of 1 (very weak) to 10 (very strong), with the exception of chewiness, which was the subject of a specific measurement protocol. This protocol led to obtain a trained and performant panel and to generate a vocabulary of hierarchical sensory attributes.

Key Words: Descriptive quantitative analysis, Sensory attributes, Aloco, Frying, Banana, Hybrid, Texture, Quality.

1 SCOPE OF THE STUDY

The objective of this study is to develop an objective methodology to assess the sensory quality of fried plantain (Aloco) using a trained panel. Ultimately, this study will make it possible to obtain the sensory profile of the Aloco from different plantain genotypes.

2 REFERENCES

AFNOR. Norme française ISO 5492 - Analyse sensorielle - Vocabulaire (2009).

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3 GENERALITIES ON ALOCO

Aloco is a local and typically ivorian product. Initially consumed as a snack, Aloco is now a real main food for many consumers. It can be eaten with fish, meat, egg, and a paste of mixte tomato and pepper, etc. Aloco is obtained after frying slices of ripe plantains. However, the variety of the plantain as well as its ripening stage and the frying conditions (time, state of oil, etc) are the factors which can influence the sensorial properties of Aloco.

4 ALOCO PREPARATION IN LABORATORY CONDITIONS

4.1 Raw material

Three cooking hybrids (Pita 3, Zakoi and SH 3640) and one local plantain variety (Corne 1) have been used in this study (Table 1). These genotypes were selected because they have contrasting physicochemical, organoleptic and technological characteristics. Fruits were harvested at the mature green stage (appearance of a first yellow finger on the bunch), in Azaguié in an experimental plantation of the National Center for Agronomic Research (CNRA) of Côte d'Ivoire.

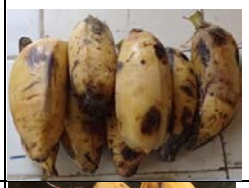
4.2 Plantain ripening stage

Fruits were kept ripen at the room temperature (Figure 1) and sampled at different ripening stages including yellow with green tips (bv)", "yellow (j)" and "yellow with black spots (jt) (Table 1). These stages are physically assessed by their peel color and their loss of firmness.

Figure 1: A bulk storage of Zakoi variety stored at room temperature for ripening

Table 1 : Banana genotypes and their ripening stages used for Aloco preparation

Sub-group	Variety	Ripening stage	Number of days of storage	Picture
Cooking Hybrid	Pita 3	Yellow with green tips	11 ~ 14	
		Yellow	12 ~ 15	
		Yellow with black spots	19 ~ 21	
	Zakoi	Yellow with green tips	7 ~ 8	

Sub-group	Variety	Ripening stage	Number of days of storage	Picture
		Yellow	9 ~ 13	
		Yellow with black spots	13 ~ 15	
	SH3640	Yellow with green tips	9 ~ 11	
		Yellow	11 ~ 13	
		Yellow with black spots	14	
Plantain	Corne 1	Yellow with green tips	13	
		Yellow	13 ~ 15	
		Yellow with black spots	19 ~ 21	

4.3 Steps of Aloco preparation

Figure 2 describes the preparation steps of Aloco in laboratory conditions.

4.3.1 Step 1: Raw material

Plantain fruits must be taken at the suitable ripening stage for the preparation of Aloco (Table 1).

4.3.2 Step 2: Washing and peeling the ripe banana

Wash plantain fruits in the tap water and peel them.

4.3.3 Step 3: Cutting the banana pulp

Using a stainless-steel knife, cut the pulp lengthwise twice, then make some cross-cuts so as to obtain slices of approximately 2 cm.

NB: The riper the fruit, the larger the pieces should be, to prevent the pulp from becoming too pasty. Conversely, the less ripe slices of pulp should be slightly smaller for optimal cooking.

4.3.4 Step 4: Frying the slices

The slices of plantain pulp were fried by total immersion in excess refined and preheat palm oil, using an electric fryer thermostat setting. In this study, we used the “Deep Fryer DF7702-GS SMART TECHNOLOGY.

- ***Oil quality and quantity***

Use refined palm oil in sufficient quantity (ratio amount of pulp / amount of oil (W/V): 1/6). Use the oil only once.

- ***Amount of pulp to fry***

Introduce 600 g of plantain slices in 3L of oil previously heated.

NB: 3 to 15 fruits depending on the variety are need to obtain 600 g of pulp.

- ***Frying time and temperature***

The optimum frying temperature was obtained at 150 °C for 10 min. During frying, it is essential to flip the slices with a skimmer every 3 min for homogeneous cooking of the slices.

NB: The frying time can be longer or shorter according to the technological peculiarity of certain varieties. In addition, too low or too high temperatures must be avoided, to limit a great absorption of the oil by the slices in the first case, or to avoid caramelization of the surface of the slices and while the inner remain uncooked, in the last case.

4.3.5 Step 5: Draining of Aloco

At the end of the frying, Aloco is drained for 1 min using a stainless-steel colander to remove excess frying oil.

4.3.6 Step 6: Aloco storage conditions

Wrap Aloco in aluminum foil to prevent a rapid cooling.

Figure 2: Steps of the preparation of Aloco

1: *Bunch of Zakoi variety at the ripe stage suitable for the preparation of Aloco*
2*: Weighing the pulp*
3a*: Cutting the pulp into slices (approximately 2 cm);* ***3b****: Slices of pulp ready to fry*
4a*: Frying of the slices by total immersion at 150 ° C;* ***4b****: Turning the slices using a skimmer*
5*: Draining the Aloco*
6*: Wrapping Aloco in aluminum foil (ready for tasting)*

5 TASTING SEQUENCE

5.1 General Information

5.1.1 Test responsible person/group animator

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5.1.2 Date/Time Phase of the test

The tests were carried out over the period from 08/17/2021 to 12/14/2021, at 3 p.m.

5.2 Sample

5.2.1 Planning of sample preparation

A sample preparation and tasting planning have been established to allow the panellists to have the samples on time and at an optimal tasting temperature (50 - 60 °C) (Table 2).

Table 2 : Aloco preparation and tasting planning

Preparation and testing order	Products	Code	Frying start time	Frying time (min)	Frying end time	Tasting time
1	Al_Pi-bv	685	14h50	10	15h00	15h05
2	Al_Pi-J	304	15h00	10	15h10	15H15
3	Al_Pi-bv	500	15h10	10	15h20	15H25
4	Al_Za-j	204	15h20	10	15h30	15H35

Al_Pi-bv: Aloco from Pita 3 fruit taken at the yellow ripening stage with green tips; Al_Pi-J: Aloco from Pita 3 fruit taken at the yellow ripening stage; Al_Za-j: Aloco from Zakoi fruit taken at the yellow ripening stage.

5.2.2 Quantity of sample to be given to each panellist

Thirty to forty grammes (30 - 40 g) of Aloco, approximately 15 - 20 slices were served to the panellists for tasting.

5.2.3 Type of dish

The samples were placed in polyester plates.

5.2.4 Temperature of tasting

The tasting temperature was set from 50 ~ 60 °C. A temperature sensitive probe was inserted into the heart of a reference sample to monitor this temperature.

NB: If the temperature of the Aloco slices cannot be controlled, an average time at the end of frying can be set at the end of which the panellists start the tasting. Mastery of this time is acquired after several rigorous simulations.

5.2.5 Repeated sample

At each tasting session, a control sample was repeated once or twice.

5.2.6 Sample Codification

The samples tasted are reported in the table below.

Table 3 : Samples codification

Sample Code	*Replicate*	*Tasting Code*	*Cultivars*	Tasting date
Al_Sh-j-10'	1	301	SH 3640	17/08/2021
Al_Pi-bv-10'	1	299	Pita 3	17/08/2021
Al_Sh-j-10'	1	310	SH 3640	24/08/2021
Al_Pi-j-10'	1	470	Pita 3	24/08/2021
Al_Pi-j-10'	2	229	Pita 3	24/08/2021
Al_Pi-j-10'	1	331	Pita 3	26/08/2021
Al_Co-j-10'	1	407	Corne 1	26/08/2021
Al_Pi-j-10'	2	291	Pita 3	26/08/2021
Al_Za-j-10'	1	312	Zakoi	05/10/2021
Al_Za-j-10'	2	220	Zakoi	05/10/2021
Al_Co-j-10'	1	612	Corne 1	12/10/2021
Al_Pi-jt-10'	1	300	Pita 3	12/10/2021
Al_Za-jt-10'	1	401	Zakoi	13/10/2021
Al_Co-j-10'	1	547	Corne 1	13/10/2021
Al_Pi-jt-10'	1	105	Pita 3	13/10/2021
Al_Za-jt-10'	2	845	Zakoi	13/10/2021
Al_Pi-jt-10'	1	101	Pita 3	14/10/2021
Al_Pi-jt-10'	1	505	Pita 3	14/10/2021
Al_Pi-j-10'	1	101	Pita 3	19/10/2021
Al_Za-j-10'	1	274	Zakoi	19/10/2021
Al_Pi-j-10'	2	575	Pita 3	19/10/2021
Al_Za-j-10'	2	615	Zakoi	19/10/2021
Al_Za-j-10'	1	411	Zakoi	20/10/2021

Sample Code	*Replicate*	*Tasting Code*	*Cultivars*	Tasting date
Al_Pi-j-10'	1	054	Pita 3	20/10/2021
Al_Za-j-10'	2	105	Zakoi	20/10/2021
Al_Pi-j-10'	2	844	Pita 3	20/10/2021
Al_Za-jt-10'	1	010	Zakoi	02/11/2021
Al_Za-jt-10'	2	361	Zakoi	02/11/2021
Al_Co-jt-10'	1	200	Corne 1	09/11/2021
Al_Pi-bv-10'	1	552	Pita 3	09/11/2021
Al_Pi-bv-10'	1	700	Pita 3	11/11/2021
Al_Pi-jt-10'	1	020	Pita 3	11/11/2021
Al_Pi-j-10'	1	152	Pita 3	11/11/2021
Al_Pi-jt-10'	2	388	Pita 3	11/11/2021
Al_Pi-j-10'	1	100	Pita 3	16/11/2021
Al_Za-j-10'	1	030	Zakoi	16/11/2021
Al_Pi-j-10'	2	162	Pita 3	16/11/2021
Al_Za-jt-10'	1	348	Zakoi	16/11/2021
Al_Za-j-10'	1	212	Zakoi	10/12/2021
Al_Sh-bv-10'	1	330	SH 3640	10/12/2021
Al_Za-j-10'	2	142	Zakoi	10/12/2021
Al_Sh-jt-10'	1	748	SH 3640	10/12/2021
Al_Co-j-10'	1	441	Corne 1	14/12/2021
Al_Sh-j-10'	1	577	SH 3640	14/12/2021
Al_Pi-j-10'	1	105	Pita 3	14/12/2021
Al_Sh-j-10'	2	845	SH 3640	14/12/2021

***46 samples; All the samples were fried for 10 min**.*

***Al_Sh-bv-10':** Aloco from SH3640 variety taken at the yellow ripening stage with green tips; **Al_Sh-j-10':** Aloco from SH3640 variety taken at the yellow ripening stage; **Al_Sh-jt-10':** Aloco from SH3640 variety taken at the yellow ripening stage with black spots.*

***Al_Pi-bv-10':** Aloco from Pita 3 variety taken at the yellow ripening stage with green tips; **Al_Pi-J-10':** Aloco from Pita 3 variety taken at the yellow ripening stage; **Al_Pi-jt-10':** Aloco from Pita 3 variety taken at the yellow ripening stage with black spots.*

***Al_Co-j-10':** Aloco from Corne 1 variety taken at the yellow ripening stage; **Al_Co-jt-10';** Aloco from Corne 1 variety taken at the yellow ripening stage with black spots.*

***Al_Za-j-10':** Aloco from Zakoi variety taken at the yellow ripening stage; **Al_Za-jt-10':** Aloco from Zakoi variety taken at the yellow ripening stage with black spots.*

5.3 Service

5.3.1 Number of samples tasted by session

Two to five samples were tasted per session.

5.3.2 Type of service

The samples were served to the panellists one after the other (monadic service).

5.4 Panel

5.4.1 Number of panellists who participate in this study

The panel consisted of 8 - 16 persons per session. They were men and women, aged 22 to 65 and selected from among the personnel of CNRA technological station of Bingerville.

5.4.2 Training of panel

The panellists were trained, according to the method described in the RTBfoods deliverable (Maraval *et al.,* 2018).

Five (5) sessions were carried out to evaluate the performance of the panel. Four different Aloco samples from different variety taken at different ripening stages were used.

5.4.3 Panel performance

The panel performances (repeatability and agreement with panel) are provided in the Excel file: "*performance panel Entrainement_Aloco_180522_v3_SOP*" attached to this SOP.

5.5 Vocabulary

Based on consumers feedback and the French standard ISO 5492 - Sensory analysis - Vocabulary (AFNOR, 2009), objective descriptors for Aloco as well as their measurement protocol have been defined (Table 4).

All attributes were rated on a scale of 1 (very weak) to 10 (very strong), except for chewiness which was measured according to the methodology developed on boiled plantain by (Kouassi *et al.,* 2022).

5.5.1 Chewiness specific evaluation

For the measurement of chewiness, the panellists were asked to chew, as usual, the same quantity of sample (here 3 slices of Aloco) and to record the number of chewing before swallowing the product. Since the chew count varies greatly from one panellist to another, this number was computed in a non-dimensionalised form for each panellist and then converted to a value between 1 and 10 (1 being the lowest dimensionless value of all products and all panellists, and 10 the highest). Thus, a chewable product is a product that requires little chewing. Therefore, more the product is chewable closer the value is to 1.

NB: It is essential that panellists chew a fixed quantity of sample.

Table 4 : Definition and measurement protocol of Aloco attributes

Type	Attributes	Definition	How to measure?	Scale
VISUAL	**Color Homogeneity**	Uniformity of the color	Observe the surface of the Aloco slices and assess the intensity of the color homogeneity	1: Low 10: High
ODOR	**Frying odor**	Intensity of perception of the smell of frying	Evaluate the intensity of the smell of frying upon receipt of the sample	1: Low 10: High
TOUCH	**Greasy appearance**	Amount of oil that remains on the fingers after touching the Aloco	Apply pressure with the fingertips on 2 or 3 slices and assess the amount of oil remaining on the fingers or flowing	1: Low 10: High
	Sticky between slices	Force required to separate individual slices adhering to each other using a hand	Touch the Aloco slices and assess the strength needed to individualize them	1: Low 10: Strong
TEXTURE IN MOUTH	**Firmness**	Force required to achieve deformation, penetration or breakage of Aloco slices	Put in the mouth one or two slices of Aloco and evaluate the force necessary to obtain the deformation of the product between the teeth during the first compression	1: Soft 10: Firm
	Stickiness	Force required to peel off the fraction of product adhering to the interior of the oral cavity	Press a slice of Aloco between the molars and assess the adhesion of the product.	1: Low 10: Strong
	Chewiness	Energy or number of chewing required to chew the Aloco to make it ready to swallow	Place 3 slices of Aloco in your mouth, chew them at the rate of one chew per second and assess the number of chews before swallowing (NB: chew the same amount of Aloco)	Number of chews
TASTE	**Sweetness**	Elemental flavor caused by dilute aqueous solutions of various substances such as sucrose or aspartame	Put a slice of Aloco in the mouth, chew it and rotate it on the tongue to detect the sweet flavor	1: Low 10: Strong

Type	Attributes	Definition	How to measure?	Scale
	Acid taste	Elemental flavor caused by dilute aqueous solutions of most acidic substances (for example, citric acid and tartaric acid)	Put one or two slices of Aloco in the mouth, chew it and swirl it over the tongue to detect the acidic flavor	1: Low 10: Strong
	Saltiness	Complex taste sensation usually due to the presence of salt	Put a slice of Aloco in the mouth, chew it and turn it over the tongue to detect the salty flavor	1: Low 10: Strong
MOUTH IMPRESSION	**Fat feeling**	Greasy impression on the surface of the Aloco slices during chewing	Evaluate the feeling of fat when chewing Aloco	1: Low 10: Fat
	Astringency	Complex sensation, accompanied by contraction, stretching or puckering of the oral mucosa, produced by substances such as tannins from persimmon or sloe, cashew apple	Once the flavors are detected, the astringency is felt by swirling the product in the mouth	1: Low 10: Strong
AROMA	**Plantain aroma**	Intensity of the plantain aroma when tasting Aloco	Chew a second slice of the sample as usual and allow air to enter your mouth during this step-in order to detect aromas by retro-olfaction	1: Low 10: Strong

6 APPENDICES

6.1 Annex 1: Panel performance

Panelists	Performance	Homogeneity	Frying odor	Greasy appearance	Sticky between slices	Firmness	Stickiness	Chewiness	Sweetness	Acid taste	Saltiness	fat feeling	Astringency	Plantain aroma	Nbr "yes"	% yes	Decision
J1	Repetability	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	13	100	R
J2	Repetability	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	12	92	R
J3	Repetability	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	13	100	R
J4	Repetability	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	12	92	R
J5	Repetability	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	12	92	R
J8	Repetability	yes	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	12	92	R
J10	Repetability	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	12	92	R
J14	Repetability	yes	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	no	no	10	77	R
J16	Repetability	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	13	100	R
J17	Repetability	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	13	100	R
J18	Repetability	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	13	100	R

Panelists	Performance	Homogeneity	Frying odor	Greasy appearance	Sticky between slices	Firmness	Stickiness	Chewiness	Sweetness	Acid taste	Saltiness	fat feeling	Astringency	Plantain aroma	Nbr "yes"	% yes	Decision
J1	Agreement	yes	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes	12	92	A
J2	Agreement	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	12	92	A
J3	Agreement	yes	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	no	yes	11	85	A
J4	Agreement	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	13	100	A
J5	Agreement	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	12	92	A
J8	Agreement	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	13	100	A
J10	Agreement	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	12	92	A
J14	Agreement	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	no	yes	yes	11	85	A
J16	Agreement	yes	yes	yes	no	yes	yes	yes	yes	yes	no	yes	yes	yes	11	85	A
J17	Agreement	no	yes	yes	no	no	yes	yes	yes	yes	no	yes	yes	yes	9	69	nA
J18	Agreement	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	13	100	A

6.2 Annex 2: Pictures to illustrate the tasting sessions

Figure 3: Illustrations of the Aloco tasting sessions

1: *Monitoring of sample temperature*
2a et 2b: *Tasting of Aloco by trained panel and vocabulary generation*

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