Some physicochemical properties of flours from four traditional varieties of cassava grown in Côte d'Ivoire

ABSTRACT

Aims: The study evaluated the physicochemical properties of flours producted from four traditional varieties of cassava (*Manihot esculenta*Crantz) grown in Côted'Ivoire.
Study design:the objective was to compare theirs characteristics in order to assess their suitability for processing and agro-industrial application.
Place and Duration of Study:this study was conducted at the Laboratory of Biocatalysis and Bioprocesses, University Nangui Abrogoua(Abidjan, Côte d'Ivoire) between the years 2017 and 2020.
Methodology: this study was conducted with four traditional varieties varieties of cassava (Yacé, Cahobahi 1, Bonoua 37, and Bonoua 34). Cassava roots were harvested at maturitythenwashed, peeled, gratted, dried and milledintoflour. Physicochemicalanalprocessingyzesincludedproximate composition (moisture, ash, organicmatter, reductingsugar, starch rate, titratableacidity, pH and hydrocyanicacid) usingmethods standard AOAC The resultswereanalyzedusinganalysis of The Resultsshowedsignificantdifferencesamong the flours for most of the parametersstudiedThe floursexhibitedlowmoisture content (between 10.55±0.15 and 12.97±0.55 %), indicating good storagestability, and high starch contents (between 29.8±1.1 and 37.7±1.1 %), reflecting high energypotential.
Conclusion:the four traditional cassava varieties studied exhibited distinct physicochemical properties suggesting differentiated technological uses. These findings highlight the potential for local cassava varieties in the development of food products in Côte d'Ivoire.

Keywords: flours ;cassava ; biochemical properties ; traditionalvarieties, Côted'Ivoire.

1.INTRODUCTION

Cassava (*Manihot esculenta*Crantz), native to Latin America (Hillocks et al., 2002a), is increasingly cultivated in nearly 100 countries (all developing), including more than 30 African countries (Djilemo, 2007). Tubers serve as a staple food for nearly 800 million people in the tropics (Djoulde, 2005). World production in 2022 is estimated at 330 million tones, of whichNigeria is the world's leading producer with 60.8 million tones, or 18% of world production (FAOSTAT, 2022). Cassava has played and continues to play a major role in efforts to alleviate

food crises due to its efficient production of food energy, available all year round, extreme tolerance of stressful conditions and ability to smallholder agriculture and the food system in Africa (Maziya-Dixon et al 2007).
Cassava being highly perishable and the presence of cyanogenic compounds in its roots require their processing immediately after harvest (Westby, 2002). One of the best ways to preserve them is to process them into flour and/or starch (Perez et al., 2005). This is why cassava flour is an ingredient used increasingly in the manufacture of a significant number of commercial food products. In fact, it is used in bakeries and pastries where it is used in the preparation of biscuits, cakes, ice creams and ice cream cones, flakes, pasta, puff pastry, etc. (Akoroda, 2007).
Given its importance in the food and non-food industry, it is our responsibility to know the physicochemical properties of cassava flour from the four varieties of cassava. The aim of our work aims to determine some properties of flours from four varieties of cassava such as: *Yacé*, *Cahobahi* 1, *Bonoua* 37 and *Bonoua* 34 in order to be able to popularize them for their use in industry.

2.MATERIALS AND METHODS

2.1 Material

2.1.1 Plant material

The tuberous roots of cassava (*Manihot esculenta*Crantz) used in this study are exclusively traditional varieties which are: *Yacé*, *Cahobahi*1, *Bonoua* 37 and *Bonoua* 34. They are cultivated on the experimental plots of the National Agronomic Research Center (CNRA) of BOUAKÉ (central Ivory Coast). These are tuberous roots 12 months old. The *Yacé* variety was used as a control during our study.

Yacé

***Bonoua* 34**

***Bonoua* 37**

*Caho**bahi*** **1**

FIg.1:Tuberous roots of the four cassava varieties

2-2. Methods

2.2.1.Methods of obtaining cassava root flour

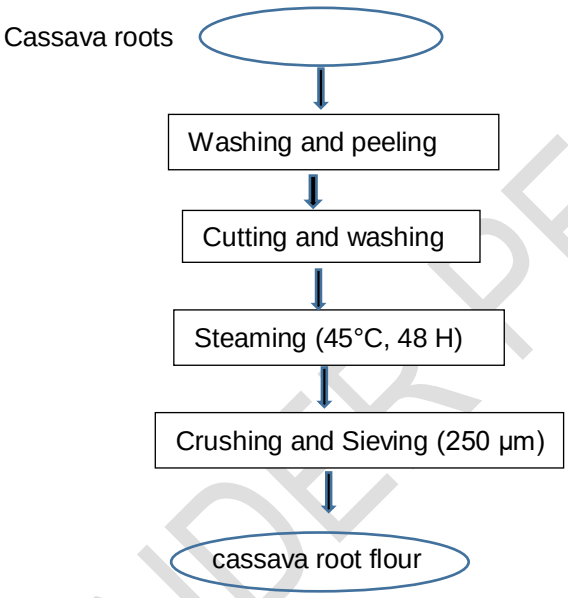

Figure 2: Diagram for obtaining cassava root

2.2.2.Analyzes

2.2.2.1.Water content

The moisture content of cassava flour was determined according to the method (AOAC, 2005). Five (5) g of sample (PE) are weighed into previously tared porcelain crucibles. The crucible and sample assembly (M1) is brought to the oven at 105°C for 24 hours. At the end of the drying time, the crucible removed from the oven (M2) is placed in a desiccator for cooling before being weighed.

$$\textbf{Humidity (\%)} = \frac{M_1 - M_2}{PE} \times 100$$

PE = sample mass (g);
M1 = mass of crucible (g) + sample;
M2 = mass of crucible (g) + driedsample;
MF : freshmaterial.

2.2.2.2 Ash and Organic matter rate

The methods for determining the ash and organic matter content of cassava root powder or starch are those described by the AOAC (2005). Five (5) g of sample weighed in a porcelain crucible of known mass (sample + crucible assembly) were calcined in a muffle furnace at 550 °C until it became a white ash (5 h). The incinerated sample was placed in adesiccator for cooling for 30 min. The crucible containing the calcined sample was weighed with a precision balance. The ash content was determined according to the following mathematical relationship:

$$\textbf{Ash (\%)} = \frac{M_1 - M_2}{M_1} \times 100$$

M1 = sample mass (5 g);
M2 = mass of crucible;
M3 = mass of crucible (g) + calcinedsample ;
MS : dry matter.

The organic matter content was determined from the following mathematical relationship.

Organic matter (%) = 100 – humidity – ash

MS: dry matter;
Humidity (g/100 g MS);
Ash(g/100 g MS).

2.2.2.3 Level of reducing sugars

The ethanol-soluble reducing sugars in cassava root powder were determined using the method described by Dubois et al. (1956) using phenol and concentrated sulfuric acid. The prepared ethanol-soluble extract (0.2 mL) was collected and placed in a test tube. 1.8 mL of distilled water and 1 mL of DNS (3,5-dinitrosalicylic acid) were successively added to this volume. The mixture was heated in a boiling water bath (Model HH-W600, Paris, France) for 5 min. The reaction mixture was allowed to cool for 10 min at room temperature and 7 mL of distilled water was added. Optical density readings were performed at 546 nm using a spectrophotometer (UV-1280, SHIMADZU, Sanjo, Japan) against a control containing all products except the ethanol-soluble extract. Optical density was converted to the amount of reducing sugars using a standard curve obtained from a glucose

solution (1 mg/mL). The reducing sugar content was calculated using the equation.

$$\textbf{Reducerssugars}\ (\textbf{g/100gMS}) = \frac{\Delta \mathbf{DO} \times \mathbf{V}_{ext}}{\mathbf{a} \times \mathbf{Vf} \times \mathbf{Mf}} \textbf{x100}$$

DO : opticaldensityreadwith a spectrophotometer
Vext : volume of sampletaken ;
Vf : total volume of the solution obtained for reading ;
Mf : powder mass ;
a : value obtained in the equation of the straight line of the standard curve ;
MS : dry matter.

2.2.2.4 Starch content

The level of starch, amylose and amylopectin was determined by the method of Jarvis and Walker (1993) using iodine.
A mass of 0.1 g of cassava powder or starch is dissolved in 5 mL of potassium hydroxide (1 N). The mixture is thoroughly homogenized by manual stirring for 2 minutes at room temperature (28 °C). The alkalinity of this solution is neutralized with 5 mL of hydrochloric acid (1 N).
Then, the mixture is boiled in a boiling water bath (Model HH-W600, Paris, France) for 15 minutes. The volume of the mixture is adjusted to 10 mL with distilled water. It is centrifuged at 4000 rpm for 10 minutes. The resulting supernatant is filtered with a Whatman No. 42 filter. The filtrate is used for starch determination. Using the measurements taken, the proportions of total starch, amylose and amylopectin in the samples were calculated using the following mathematical formulas :

$$\textbf{Starch(\%)} = \frac{\Delta \mathbf{DO}_{580} \times \mathbf{V}_{ext}}{\mathbf{a} \times \mathbf{Vf} \times \mathbf{M}} \textbf{x 100}$$

$$\textbf{Amyloidosis(\%)} = \frac{\Delta DO_{720} \times V_{ext}}{a \times Vf \times Mf} \times 100$$

DO : opticaldensityreadwith a spectrophotometer
Vext : volume of sampletaken ;
Vf : total volume of the solution obtained for reading ;
Mf : powder mass ;
a : value obtained in the equation of the straight line of the standard curve ;
MS : dry matter.

Amylopentin (%)=Starch - Amyloidosis

Starch(g/100 g extracted of starch)
Amyloidosis (g/100 g extracted of starch)

2.2.2.5 pH

The pH is determined according to the method of Medoua (2005). Ten (10) g of flours are mixed with 100 ml of distilled water.The mixture obtained is homogenized by mechanical stirring for 15 min at room temperature and centrifuged at 3000 rpm for 15 min in a benchtop centrifuge. The supernatant is collected and its pH determined using a calibrated pH meter.

2.2.2.6 Titratable acidity

It is determined according to the method of solution by adding 4 drops of 1% phenolphthalein (w/v) as a colored indicator until the pale pink color persists for 30 seconds.
Thus, 10 g of powder was mixed with 100 mL of distilled water. The mixture was homogenized by mechanical stirring for 15 min and centrifuged at 3000 rpm for 15 min in a benchtop centrifuge (JOUAN BR 4i, St Nerblan, France). The supernatant was collected. A 10 mL aliquot of this supernatant was titrated with sodium hydroxide solution (0.1 N) by adding 4 drops of phenolphthalein (1%, w/v) as a color indicator until a pale pink color change persisted for 30 seconds. The titratable acidity was calculated from the following mathematical expression:

$$\textbf{Titratable acidity (méq/100g)} = \frac{N \times Veq \times 10^4}{Me \times V0}$$

V0: volume (mL) of the test portion;
Veq: volume (mL) of soda (0,1 N) poured to the equivalence
Me: masse (g) of sample;
N:normality of the soda solution

2.2.2.7 Hydrocyanic acid

The hydrocyanic acid content of cassava root powder was determined using the method described by Holleman and Aten (1956). 20 g of powder were dissolved in 200 mL of distilled water. Maceration was carried out for 18 hours. The macerate was distilled for 4 hours. The distillate (100 mL) was collected in 20 mL of sodium hydroxide (5%, w/v). After a 2/5 dilution in a final volume of 100 mL of distilled water, the cyanogen ions in the distillate were determined using a silver nitrate solution (0.02 N) in the presence of 8 mL of potassium iodide (5%, w/v). One molecule of silver nitrate reacts with two molecules of hydrocyanic acid.
The hydrocyanic acid content was calculated using the following mathematical relationship:

$$\textbf{HC(mg /100gMS)} = \frac{1,08 \times Veq}{Me} \times 100$$

Veq: volume (mL) d'AgNO3 paid of equivalence;
me : masse (g) of sample;
HCN : hydrocyanicacid;
MS : dry matter;
1,08 : conversion Coefficient of silver nitrate intohydrocyanicacid.

2.2.3 Statistical analysis of data

Statistical analyzes were performed on eight samples with three repetitions for each sample. STATISTICA 7.1 software was used for these analyses. Statistical tests such as analysis of variance (ANOVA) for comparing varieties with

each other based on dependent variables according to the "Duncan" multiple comparison test. They made it possible to establish the variability within the different samples analyzed and the statistical significance was defined at the threshold of α = 5%.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1 Physicochemical analyzes of flours from four traditional varieties of cassava

The moisture content of the flours of the four traditional varieties of cassava is between 10.55±0.15 and 12.97±0.55 %. The varieties, Bonoua 37 and Bonoua 34 have the highest humidity levels while, *Cahobah*i 1 has a lowest humidity levels. The humidity levels of these different varieties are approximately equal. The ash rate of flour of a variety varies between 1.38±0.06 to 2.4±0.26 %. *Yacé*and *Cahobahi* 1 have the most statistically ($P< 0.05$) high values while the varieties *Bonoua* 37 and *Bonoua* 34 have lower values. Concerning the level of organic matter, it is between 86.33±0.07 and 87.37±0.03 %. All the values obtained are statically identical ($P \geq .05$).

The reducing sugar level is between 0.27 ± 0.05 and 6.06 ± 0.41%,*Cahobahi* 1 has the highest reducing sugar level while *Yacé* has the lowest.

The titratable acidity of these varieties varies from 2.3±0.5 to 5.5±1.1 meq/100g while the pH is between 5.75±0.03 and 6.73±0.08. The pH values of all the flours of the varieties studied are significantly identical ($P \geq 0.05$) while the highest titratable acidity is that of *Yacé* and the lowest is that of *Cahobahi* 1. As for the rate of hydrocyanic acid, it varies from 0.016±0.01 to 0.057±0.01 mg/100g. The *Yacé*variety has the most statistically ($P< 0.05$) high level of hydrocyanic acid while all the values obtained are statically identical ($P \geq 0.05$) and have the lowest values

The starch content of the flour of these varieties varies from 29.8±1.1 to 37.7±1.1 %. The highest rate is that of *Bonoua*34 and the lowest is that of *Cahobahi* 1. Compared to the *Yacé* variety with 33.8±1.9 %, the highest starch levels are those of all the other varieties except *Cahobahi* 1.

Concerning the levels of amylose and amylopectin of these varieties, that of amylose varies from 18.4 ± 1.1 to 26.2 ± 1.2% while that of amylopectin is between 70.8 ± 1.6 and 81.8±0.9 %.The variety with the highest amylose level and the lowest amylopectin level is *Bonoua* 37. The variety with the lowest amylose level and the highest amylopectin level is *Yacé.*

Table 1: Physicochemical properties of flours from four traditional varieties of cassava

Composition (%)	Cassavavarieties			
	Yacé	*Cahobahi* 1	*Bonoua* 37	*Bonoua* 34
Humidity	11,21±0,05[b]	10,55±0,15 [a]	**12,97±0,55 [c]**	**12,12±0,12 [c]**
Ash	2,4±0,26[b]	2,08±0,06[b] [b]	1,37±0,16[a]	1,38±0,06[a]
Materials organic	86,39±0,07[a]	87,37±0,03 [a]	85,66±0,25 [a]	86,5±0,03 [a]
Sugarsréducers	0,27±0,05[a]	**6,06±0,41[c]**	3,81±0,03[b]	0,35±0,01 [a]
Starch	33,8± 1,2 [b]	29,8±1,1[a]	35,1±1,5 [b]	**37,7±1,1[b]**
Amyloidosis	20,2±0,75 [a]	18,4±1,1[a]	18,2±0,25 [a]	**26,2±1,2 [b]**
Amylopectin	70,8±1,6 [a]	**81,6±2,1[c]**	**81,8±0,9[C]**	73,8±1,2 [b]
Titratable acidity (méq)	2,3±0,5[a]	**5,5±1,1[b]**	3,6±0,14[ab]	2,66±0,5[a]
pH	6,73±0,08[a]	5,75±0,03[a]	6,62±0,02[a]	6,7±0,15[a]
HCN (mg/100g)	0,057±0,01[b]	0,032±0,01[a]	0,019±0,01[a]	0,016±0,01[a]

Mean ± standard deviation: n=3 Number=4
Online data followed by the same letter are not significantly different (P > 0.05).Values in bold represent the largest values and those underlined are the smallest values.

3.2 Discussion

Cassava roots having a short shelf life due to their high moisture content must be converted into non-perishable foods through food processing operations (Aboubakar*et al*., 2008). One of the best ways to preserve them is to transform them into flour (Perez *et al*., 2005) given its importance in the food industry.

The technological transformation of varieties *Yacé*, *Cahobahi* 1, *Bonoua*37 and *Bonoua* 34 cassava roots into powders has considerably reduced the level of hydrocyanic acid. This situation suggests that drying could have a beneficial effect on the level of cyanogenetic compounds contained in foods. This result has already been highlighted by Ngiki*et al.,* (2014) and Adeyeye*et al*. (2000) who worked on cassava root flours. Furthermore, the World Health Organization (WHO) has set the safe level of hydrocyanic acid in cassava flour at 1 mg/100 g (FAO/WHO, 1991). For this, varieties *Yacé*, *Cahobahi* 1*, Bonoua* 37 and Bonoua 34 cassava flours could be considered non-toxic. They could then be used for human food. The hydrocyanic acid levels of these cassava flours are lower than those of cassava root flours varieties Amakuma, Bankyefitaa, Ampong, Bronibankye, Sika and Otuhia cassava varieties grown in Ghana having hydrocyanic acid levels equivalent to 0.08 to 0.12 mg HCN / kg (Afoakwa*et al.,* 2012).

The moisture levels of varieties *Yacé,Cahobahi*1, *Bonoua* 37 and *Bonoua* 34 cassava root flours are less than 13 %. According to Codex, 1991, the moisture content in flour must not exceed 13%. They make it possible to guarantee good conservation of these food products by avoiding their deterioration due to the development of microorganisms (Srirothe*t al.,* 2000; Harris and Koomson, 2011). The moisture levels obtained in this work are close to those of cassava root flours varieties Rayong 5, Kaesetsart 50 (KU50), Rayong 2, Hanatee and KMUL 36-YOO2, which have rates of 9.2 to 12, 3 % (Charles *et al.*, 2005) and those of the seven traditional varieties of cassava (10.79 ± 0.03 to 12.92 ± 0.31 %) obtained by Marise*et al*. (2019). The root flours of the four varieties of cassava could be preserved for a long time without risk of development of microorganisms in order to be used in the food industry.

The flours of the varieties studied are rich in starch. The high level of starch in the root flours of the varieties studied could favor their use in bread making. The values obtained in this study are close to those reported by Marise*et al.,* (2019) on the seven traditional varieties of cassava (28.71 ±0.34 to 44.06 ±0.56 %). The starch content of the Bonoua 34 variety is higher than those of cassava root powders varieties Kaesetsart 50, Rayong 5, Hanatee and KMUL 36-YOO2, varying from 34.2 to 35.1% reported by Charles *et al.,* (2004).

In cassava root starches, levels of amylopectin are higher than those of amylose. This situation suggests that the starches of cassava roots varieties *Yacé*, *Cahobahi* 1, *Bonoua* 37 and *Bonoua* 34 do not present significant thermal and enzymatic rigidities (Sandhu *et al*., 2005 ; Liu *et al*., 2007). This same situation has already been revealed by Falade et al. (2010), who worked on cassava starch.

The reducing sugar levels of cassava root flours varieties *Cahobahi* 1, *Bonoua*37 are higher than those of improved cassava root flours varieties TMS90/0581, TMS98/0505 TMS98/0524 which vary from 0.28 ± 0.02 to 0.48 ± 0.01 % (Otache*et al.,* 2017). The ash levels of the cassava root flours studied do not exceed 3g/100g. According to (Codex, 1991), flour intended for human consumption has an ash content which must not exceed 3%. Thus, the root flours of the seven varieties of cassava studied with ash levels below 3% (Codex, 1991) could be intended for human consumption. These ash levels are close to those of cassava root flours varieties Amakuma, Bankyefitaa, Ampong, Bronibanksye, Sika and Otuhia varying from 1.71 to 2.34 % (Afoakwa*et al*., 2012). On the other hand, they are higher than those of varieties KU 50 cassava root flours, ranging from 0.91 ± 0.08 to 1.24 ± 0.02 % (Chotineeranat*et al*., 2006).

The pH of the *Yacé*, *Cahobahi*1, Bonoua 37 and Bonoua 34 cassava root flours are around 6. They are close to those of the varieties NSICcv-48 cassava root flours, 5.64 (Emnace, 2025). These pH of cassava root flours are lower than these of cassava flours variety 92/0326, 7.01 (Aryee et al., 2006), Zoklo, 6.74 (Koko *et al*., 2014). On the other hand, they are higher than that of cassava root flours variety 081/00356, 4.99 (Aryee*et al*., 2006). They can prevent microbial proliferation, improve the bioavailability of minerals and stimulate the secretion of endogenous enzymes through acidification (Smulders and Greers, 1998). The cassava root flours of the varieties studied have low titratable acidity, cassava root flour variety Zoklo, 2.57 meq/100 g (Koko *et al*., 2014).

Conclusion

Cassava root flours varieties *Yacé*, *Cahobahi* 1 *Bonoua*37 and *Bonoua* 34 are non-toxic and preservable. They could be used in the food industry. They are rich in starch with a higher level of amylopectin than amylose. However, the starch of these varieties could be used in food preservation.

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Author(s) herebydeclarethat NO generative AI technologies such as Large LanguageModels (ChatGPT, COPILOT, etc) and text-to-image generators have been usedduringwriting or editing of thismanuscript.

COMPETING INTERESTS

Authors have declaredthat no competinginterestsexist.

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REFERENCES

Aboubakar N.Y.N., Scher J., Mbofung C.M.F. (2008). Thermal physicochemical properties and microstructure of six varieties of taro flours and starches (Colocasia esculenta L. Schott). Journal Food Engineering, 86:294-305. http://doi.org/10.1016/j.jfoodeng.2007.10.006

Adeyeye E.I., Arogundade L.A., Akintayo E.T., Aisida O.A., Alao P.A. (2000). Calcium, zinc and phytate inter relationships in some foods of major consumption in Nigeria. Journal of Food Chemistry, 71: 435-441. http:// doi.org/10.1016/S0308-8146 (00)001559-x

Afoakwa O.E., Clément A., Agnès S.B., Chiwona-Karltun L. (2012). Chemical composition and cyanogenic potential of traditional and high yielding CMD resistant cassava (Manihot esculenta Crantz) varieties. International Food Research Journal,19:175-181. http:// doi.org/10.1016/j.eja.2017.01.XXXX

Akoroda M. (2007). Consumption and organization of the cassava market in West Africa. In “Potentials for processing cassava (Manihot esculenta Crantz) in West Africa”,

AOAC. (2005). Official method of analysis of the Association of official Analytical Chemists, 5th ad. AOAC Press, Arlington, Virginia, USA.

Aryee F.N.A., Oduro I., Ellis W.O., Afuakwa J.J. (2006). The physicochemical properties of flour samples from the roots of 31 varieties of cassava. Food Control, 17:916-922. http:// doi.org/10.1016/j.foodcont.2005.06.013

Charles A.L., Chang Y.H., Ko W.C., Sriroth K., Huang T.C. (2004). Some physical and chemical properties of starch isolates of cassava genotypes. Starch, 56:413-418. http:// doi.org/10.1002/star.2003000226

Charles A.L., Sriroth K., Huang T.C. (2005). Proximate composition, mineral contents, hydrogen cyanide and phytic acid of 5 cassava genotypes. Food Chemistry, 92:615-620. http:// doi.org/10.1016/j.foodchem.2004.08.024

Chotineeranat S., Suwansichon T., Chompreeda P., Piyachomkwan K., Vichukit V., Sriroth K., Haruthaithanasan V. (2006). Effect of Root Ages on the quality of low cyanide cassava flour from Kasetsart 50. Kasetsart Journal (National Science), 40: 694-701.

Codex Alimentarius (1991). African regional standard for edible cassava flour, Codex stan 176, 1991, 3 p.

Djilemo L., (2007). Unfermented cassava flour (Manihot Esculenta Crantz): The Future of cassava cultivation in Africa. In: International cassava workshop, Abidjan, Ivory Coast, June 4 to 7, 2007.

Djoulde D.R. (2005). Development of a mixed ferment intended for the bioconversion of cyanogenic cassava tubers. Doctoral thesis. National Higher School of Agro-Industrial Sciences (ENSAI). University Ngaoundéré Cameroun, 69: 784-791.

Emnace I.C., Cayetano E. B., Villafuerte J.K., Arvin P., Sta. Iglesia, K., Lauzon R.D. 2025. Functional, physicochemical and proximate properties of flours from selected NSIC-registered cassava (Manihot esculenta) varieties. Annals of tropical Research 47(2):262-289 (2025). http:// doi.org/10.32945/atr47217.2025

FAO/WHO. (1991). Joint FAO/WHO food standards program. In: Codex Alimentarius Commission XII (Suppl. 4). Rome: FAO.

FAOSTAT. (2022). Food and agriculture Organization of United Nations. FAOSTAT production-crops and Livesstock products. Retrieved from http://www.fao.org/faostat/en /≠data/QCL.

Falade K.O., Akingbala J.O. (2010). Use of cassava for food. FoodReview. International, 27(1): 51-83. http:// doi.org/10.1080/87559129.2010/518296

Hillocks R.J., Thresh J.M., Bellotti A.C. (2002a). Cassava: biology, production and utilization. The origins and taxonomy of cassava. CABI Publishin.g. New York, USA, 1:1-11. http:// doi.org/10.1079/9780851995243.0001

Holleman L.W.J., Aten A. (1956).Traitement du manioc et produits à base du manioc dans les industries rurales. Collection FAO progrès et mise en valeur. Agriculteur.*Cahier N* °54, 115 p.

Koko C.A., Kouame B.K, Anvoh B.Y., Amani G.N., Assidjo E.N. r(2014). Comparative study on physicochemical characteristics of cassava roots from three local cultivars in Côte d'Ivoire. European Scientific Journal, 10(53): 418-432.

Liu Y. W., Shang H. F., Wang C. K., Hsu F. L., Hou W. C. (2007). Immunomodulatory activity of dioscorin, the storage protein of yam (Dioscoreaalata cv. Tainong No. 1) tuber. Food and Chemical Toxicology, 45(11): 2312-2318. http:// doi.org/10.1016/j.fct.2007.06.009

Marise A. K., Catherine B. E., Kouadio M. T., Jocelyn C. Y., Gbocho S. E. E., Patrice L. K. (2019). Physicochemical Composition of Flours From Seven New Varieties of Cassava (Manihot Esculenta Crantz) Grown and Consumed in Ivory Coast. Scholars International Journal of Biochemistry.ISSN 2616-8650 (Print) |ISSN 2617-3476 (Online) Scholars Middle East Publishers, Dubai, United Arab Emirates Journal homepage: http:// doi.org/10.21276/Sijb.2019.2.3.8

Maziya-Dixon B., Dixon A. G. O., Adebowale A. A. (2007). Targeting different end uses of Cassava: genotypic variations for cyanogenic potentials and pastin properties. International Journal of Food Science and Technology, 42(8): 969-976. International. Ottawa, Ontario, Canada, 159 p. http:// doi.org/10.1111/j.1365-2621.2006.01319.x

Medoua N.G., Mbome L.I., Agbor-Egbe T., Mbofung C.M.F. (2005). Study of the hard-to-cook property of stored yam tubes (Dioscoreadumetorum) and some determining biochemical factors. Food Research International, 38:143-149. http:// doi.org/10.1016/j.foodres.2004.09.005

Ngiki Y.U., Igwebuike J.U., Moruppa S.M. (2014). Utilization of cassava products for poultry feeding; a review. International journal of science and technology, 2(6), 48-8 http:// doi.org/10.1017/S0043933909000026

Otache M.A., Agbajor G.K., Akpovona A.E., Ogoh B. (2017). Quantitative Determination of Sugars in Three Varieties of Cassava Pulp. Asian Journal of Chemical Sciences, 3(3): 1-8. http:// doi.org/10.109734/AJOC/2017/37112

Perez E., Schultzb F.S, Pacheco F.P., Delahaye E. (2005). Characterization of certain properties of starches isolated from XanthosomaSaggitifolium (tannia) and Colocasia esculenta (taro). Carbohydrates Polymers, 60: 139-145. http:// doi.org/10.1016/j.carpol.2004.11.033

Westby A. (2002). Cassava utilization, storage and small-scale processing. In: cassava: biology, production and utilization. Editions Belloti A. C., Thresh J. M. and Hillocks R. J. CAB International, Wallingford, Oxon, UK, 281-300 pp.

Sandhu K. S., Singh N., Malhi N. S. (2005). Physicochemical and thermal properties of starches separated from corn produced from crosses of two germ pools. Food Chemistry, 89:541-548. http:// doi.org/10.1016/j.foodchem.2004.03.007.

Smulders F.J.M., Greer G.G. (1998). Integratingmicrobialdecontaminationwithorganicacids in HACCP programmes for muscle foods: prospects and controversies. *International Journal of Food and Microbiology*, 44: 149-169. http:// doi.org/10.1016/S0168 (98)00123-8

Sriroth K., Chollakup R., Chotineeranat S., Piyachomkwan K., Oates C.G. (2000). Processing of cassavawaste for improvedbiomassutilization. *BioresourceTechnology*, 71: 63-9. http:// doi.org/10.1016/S0960-8524 (99)00051-6