Characterization of Waste From Attiéké Factory: Case of Azito Village (Abidjan, Côte d'Ivoire)

Kpata-Konan Nazo Edith
Konan Koffi Felix
Kouame Yao. Francis
University Jean Lorougnon Guédé,
UFR of Environment and UFR of Agroforesterie, Daloa, Côte d'Ivoire
Gnagne Theophile
Water and Sanitation for Africa,
National Representation of Côte d'Ivoire, Abidjan, Côte d'Ivoire
Laboratory of Environmental Sciences, UFR of Sciences and Environment Management, University Nangui Abrogoua, Abidjan, Côte d'Ivoire
Tano Kablan
Laboratory of Tropical Product Food Technology, UFR of Sciences and Food Technology, University Nangui Abrogoua, Abidjan, Côte d'Ivoire

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Abstract

The control of the anaerobic digestion of cassava residues from attiéké factories requires their characterization to offer a better working environment to attiéké producers.

This study concerns at first the quantity of solid residues of cassava, dough of crushed cassava and other waste generated by the process of attiéké production. The second aspect concerns the determination of some physico-chemical parameters (COD, TKN, pH, COD/TKN). These two aspects were realized thanks to the use of a bag in synthetic fibers, a dynamometric steelyard with dial of diameter 17 cms, and the use of a gradual can of capacity 20 L. The results of this study showed that an average quantity of 1.53 tonne of manioc handled (treated) generates 1.14 m^3 of effluents and 0.16 tonne of solid waste per day. These effluents are acid with a pH ranged between 2.54 and 4.80. So they have on average a DCO of 58.79 g/L for 0,71 g/L of nitrogen. All these parameters help control the optimal conditions of anaerobic digestion of cassava effluents in the manufacturing process of attiéké.

Keywords: Cassava effluent, solid waste, attiéké production, anaerobic digestion

Introduction

In Côte d'Ivoire, cassava ranks second in food crop after yam with an annual production of 2.198 million tons (FAO, 2006).

It is both subsistence farming and cash crops for farmers. Its culture and its operations generate various activities involved in food security and thus help to fight against poverty. The tuberous roots, after processing, offer several food including attiéké is the most consumed in Côte d'Ivoire (Akoroda, 2007**).**

Indeed, attiéké is now produced and consumed throughout Côte d'Ivoire and all socioeconomic strata (Krabi *et al.*, 2015). According to Krabi *et al*. (2015), the annual production of attiéké is estimated between 18965 tons and 40000 tons. However, attiéké manufacturing process generates toxic effluents due to the high content of cassava cyanide up to 500 ppm (Asiedu, 1991 ; Chuzel *et al*., 1995 ; Ihedioha, 2002 ; Goualo *et al*., 2007). These effluents are highly loaded with organic matter with COD values ranging from 6 to 50 g/L and BOD ranging from 1.5 to 35 g/L (Chuzel *et al*., 1995 ; Marache, 2001 ; Mahan, 2004 ; Kpata, 2005 ; Ubalua, 2007 ; Kpata-Konan *et al*., 2011). Untreated and directly discharged into the nature, these effluents represent a major source of pollution for the receiving environment. Indeed, they degrade the living environment, generate odors, promote the spread of pathogens and cause risks to human and animal health (Marache, 2001 ; Okwesili *et al.*, 2016). This is particularly the case in many Ebrié villages engulfed by the city of Abidjan where many women are principally engaged in the manufacture of attiéké.

Thus, to improve the framework of attiéké production, it is necessary to develop a control strategy to scale effluent from the factory, including the Azito village (Abidjan).

This work aims to characterize waste from the processing of cassava into attiéké to assess the amount of processed cassava and solid derivatives (cassava peelings, crushed manioc paste) and liquid (cassava effluents). It also aims to determine the physico-chemical parameters (COD, TKN, pH, COD/TKN) of effluent from this transformation in order to better understand the treatment by anaerobic digestion.

Materiel et methods

Presentation of the study site

Azito village is located in the commune of Yopougon (Abidjan District) bordering the lagoon Ebrié. Azito covers an area of 35 hectares. Evaluated at 4800 inhabitants in 1988 (Anonyme 7, 1998), the population of Azito, with a growth rate of 3.5%, is now estimated at about 7770 inhabitants. The number of household amounts to 177 with an average size of 7 inhabitants per household. The main economic activities are the production of attiéké and artisanal fishing.

Quantification of solid and liquid waste from the attiéké factory
The material used for this purpose is:

A bag of synthetic fibers (rice bag) to store cassava and residues to facilitate weighing sessions.

A torque load cell to dial diameter 17 cm (Kadama Chinese) reach 50 kg and 200 g accuracy. Circular in shape, it consists of two shaped hooks "S", one to connect the bracket to the balance and the other to connect the scale to the weighing sample.

Graduated drum capacity 20 L has quantified the effluent cassava (manioc pulp press juice and washing water of the peeled cassava).

Technical analysis

Gross weight of cassava (GWC) is the average weight of cassava different weekly arrivals of cassava on the site of the factory.

Solid waste (peelings and cassava fibers) are obtained after the peeling step and manual cassava cutting. The weight of solid waste (WSW) is the average weight of solid waste from various weekly arrivals of cassava on the site of the factory.

The Weight of ground cassava (WGC) is the average crushed and pressed cassava weight of different weekly arrivals of cassava on the site of the factory.

The effluent of the factory consist of washing water of peeled cassava and pressing the liquid from the cassava paste. They are recovered and transferred into 20 L cans.

The daily average quantity processed cassava (Dqpc) obtained by the expression below:

Dqpc = (GWC x 2) / 7 is the amount of raw cassava (GWC) reduced from two weekly arrivals (2) of daily arrivals (7).

Daily flow of effluent discharged, obtained by the expression

Dfe = (AED x 2) / 7, is the amount of effluent discharged (AER) reduced from two weekly arrivals (2) of daily arrivals (7).

The specific production of effluent (Spe) expressed by the formula:

Spe = Dqpc x Dfe, is the average daily amount of processed cassava multiplied by the effluent discharge stream.

The chemical oxygen demand (COD), total Kjeldahl nitrogen (TKN) and pH were determined by the methods described by AFNOR (1994). In this study the ratio of carbon, nitrogen was obtained from the ratio COD and NTK.

Results And Discussion

Estimation of pollutant flows

The average daily amount of processed cassava is 1.53 tonne per factory. The transformation of cassava generates wastewater that amount of 1.14 m^3/day (Table I).

During the three weeks of evaluation, 16.044 tonne of cassava have been treated by the attiéké producing of Azito village. All the waste generated by the manufacturing unit was of 3,401 tonne of solid waste and 11.920 m^3 of wastewater. Reduced annually, the waste produced by the attiéké factory of Azito village are estimated at an average 54.416 tonne of solid waste and 174.720 m^3 of effluent discharged to approximately 256.704 tonne of cassava to be treated (Table I).

Table I: Weekly estimates, monthly and yearly amounts of cassava solid waste, cassava dough and effluents on the production site attiéké Azito village.

parameters	average estimate		
	Weekly	monthly	yearly
Raw cassava amount (Tonne)	5,348	21,392	256,704
Peeled cassava Quantity (Tonne)	4,214	16,857	202,288
Quantity of cassava paste (Tonne)	2,237	8,947	107,360
Solid waste (Tonne)	1,134	4,535	54,416
Amount of liquid waste (m3)	3,640	14,560	174,720

Table II: Evaluation of pollution flows on the production site attiéké Azito town. Spe = Dqpc x Dfe

	Parameters		
	Dqpc (T/day)	Dfe (m^3/day)	Spe (m^3/T)
Values	1,53	1,14	0,74

Physico-chemical characterization of the effluent from attiéké production

The physico-chemical characteristics of the effluent showed an acid effluent with a pH ranging between 2.54 - 4.80, a high load of organic matter with the values of COD varying between 33,69- 83,90 g/L. A small amount of nitrogen is between 0.62 to 0.81 g/L with an average of 0.71 g/L. As for the ratio COD / TKN, the values fluctuate between 54.69 - 103.33 with an average of 79.01 (Table III).

Table III: characteristics of the raw cassava effluent collected from the production site of attiéké Azito village

Parameters	Variation range	average values
COD (g/L)	33,69 – 83,90	58,79
TKN (g/L)	0,62 – 0,81	0,71
COD / TKN	54,69 – 103,33	79,01
pH	2,54 – 4,80	3,67

Discussion

The average amount of cassava that arrives on the production site of attiéké at Azito village is 1.53 tonne per day. Treated, cassava daily generates 0.16 tonne of solid waste and 1.14 m^3 of wastewater. This waste correspond to monthly amounts of 4.86 tonne of solid waste and 34.2 m^3 of wastewater. Reduced annually, estimates are in the range of 58.32 tonne of solid waste and 410.4 m^3 of wastewater discharged into the lagoon Ebrié by the attiéké factory of Azito village. Moreover, it gives a specific effluent production of 0.74 m^3/t cassava. The quantities of solid waste and cassava paste gradually increase according to the amount of crude processed cassava. However, production of effluents (washing water and cassava pulp press juice) is not a function of the amount of cassava. The variability of the amounts of effluents obtained after pressing the fermented cassava dough could be justified by the variability of water contents itself related to the season, the characteristics of plants, the cassava maturation rate, the climatic conditions but also the variety of cassava (Fiorentino *et al*., 2003 ; Nwokoro *et al*., 2005). Cassava used on the attiéké factory of Azito village still comes from the same production site. The variability of the quantity of the washing water level is due to the fact that producing attiéké does not always use the same volume of water for washing the peeled cassava. Indeed, the amount of water for washing the cassava is a function of the operator. Also, the volume of waste it is in continual growth view attiéké has become in recent years one of the most consumed foods in Côte d'Ivoire. In addition, this product exports increasingly in the West African sub-region (Akoroda, 2007), and knows a real interest in the country (the West) not traditionally consumer attiéké (Yeo, 2007). Indeed, an evaluation of WSA Côte d'Ivoire (2012) shows that attiéké producing of Abobo-Baoule village (Abobo) handle an average of 4.29 tonne of cassava per day. Effluent discharged daily into the wild without treatment is estimated at about 3.18 m^3. Thus, given that across the District of Abidjan, almost all of the 93 Ebrié villages engage in this activity, it is a lot of solid and liquid wastes that are produced and should be managed in effectively so that they are sources of pollution.

At the attiéké factory of Azito village, made of solid waste and cassava peelings fibers are valued for food of animal transits of Yopougon slaughter house park located in the said village. This type of valuation of cassava peels and fiber has already been observed by Ubalua (2007) in Nigeria and Alazard (1996) in Colombia. These peels are also used for feeding pigs and poultry in Brazil, Nigeria and Côte d'Ivoire (Alazard *et al*., 2006; Ubalua, 2007).

The wastewater composed of wash water cassava and cassava pressing juice are for their discharged directly into the environment without treatment. However, the effluents from cassava pressing are very acidic

(Mahan, 2004; Kpata, 2005; Kpata-Konan *et al*., 2011) with pH below 4. The acidity of raw sewage digesters observed before feeding would be partly due to the fermentation step conducted during the attiéké manufacturing process. According to Raimbault (1995), Djoulde (2003), Oguntoyinbo (2007) and Kacou (2000), lower pH, in the case of the production of fermented products, be explained by the activity of the lactic microflora. These microorganisms act on the starch they hydrolyze to produce lactic and acetic acids. Djoulde (2003) also indicates that the amylolytic activity observed during the fermentation transforms directly cassava starch to lactic acid. In addition, the cassava effluent is rich in organic matter (Colin *et al*., 2007; Ubalua, 2007) and highly toxic due to high cyanide content (Asiedu, 1991; Ihedioha, 2002). Cassava and effluents are a major source of environmental pollution in general and for the water lagoon adjacent to Azito village in which they are discharged untreated directly. In addition, these effluents are characterized by a high concentration of COD of 33.69 to 83.90 g/L, organic matter (Colin *et al*., 2007). Discharged without having undergone prior treatment, these effluents have a negative impact on the environment (Filidei *et al*., 2003; Nour-Eddine *et al.*, 2014).

Conclusion

It appears from this study that 1 ton of processed cassava in attiéké industry generates 0.74 m^3 of effluent. These wastewater cassava characterized by a high potential of methanogenic made of their high carbon concentration can be treated by anaerobic digestion. However, these effluents from cassava made of their acidity and their nitrogen deficiency are biorecalcitrant, which can inhibit anaerobic digestion. Thus, it is necessary to co-digest these cassava wastes for more efficient pollution treatment and biogas production.

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