American Research Journal of Humanities & Social Science (ARJHSS)
E-ISSN: 2378-702X
Volume-02, Issue-09, pp-41-48
September-2019
www.arjhss.com

Research Paper Open Access

Physicochemical And Sanitary Characterization Of Two Complementary Foods To Breast Milk: Sweet Potato (Ipomoea Batatas) And Taro (Colocasia Esculenta) Consumed In Côte d'Ivoire

Gnahé Dago André, Beugré Grah Avit Maxwell*, Niaba Koffi Pierre Valery, Gnakri Dago

Agro-valorization Laboratory, Agroforestry Department, Jean Lorougnon GUEDE University, P.O. Box 150 Daloa, Cote d'Ivoire

**Corresponding author: Gnahé Dago André*

ABSTRACT :- In Côte d'Ivoire, infant meals of good quality are still inaccessible to poor households. FAO and WHO then advocated the use of local complementary foods that are available, accessible and of sufficient nutritional quality. However, the nutritional value of those in the Haut Sassandra region remains unknown. Thus, a study on the physicochemical and sanitary characterization of sweet potato (*Ipomoea batatas*) and taro (*Colocasia esculenta*) from the different markets of Daloa, Issia, Vavoua and Zoukougbeu led. For this, a nutritional survey relating to the frequency of consumption of complementary foods was made. Their physicochemical characteristics were determined using the following methods: dry matter (drying 105 ° C, AOAC, 1990), ashes (incineration 500 ° C), fats (Soxhlet / hexane), proteins (Kjeldahl / 6.25), carbohydrate (by difference), energy density (Atwater, 1986). Microbiological analyzes (counts) were performed. The nutritional survey revealed that roots and tubers are used more (59 %) by mothers outside cereals. These two tubers were characterized by their high carbohydrate content (82.34±3.53% (taro)- 86.45±2.25% (white potato)) and their low fat (0.87±0.02(taro)-2.25±0.09 (pink potato)) and protein (0.74±0.06 % (taro) -3.062 ±0.5% (pink potato)). The results of the microbiological analyzes showed that the microbial load of their starch is acceptable. The different slurries prepared from these starches have an appreciable energy density (16.8-71.6 Kcal /100 mL) that can help cover the energy needs of infants and young children.

Key words: Complementary foods, porridge, nutritional value, health characteristics, nutritional survey, sweet potato, taro

I. INTRODUCTION

From birth to 6 months, all nutritional requirements of the infant are covered by breast milk. Beyond this age, breast milk is no longer sufficient to fully cover energy and protein requirements (Akre, 1989) [1]. This is the so-called weaning period that extends from 6 months to 1 year or 2 years. During this period, new foods must be brought in liquid or semi-liquid form to supplement the intake of breast milk. These new foods given to infants during the weaning period are called complementary foods and must provide in balanced proportions the major nutrients: proteins, fats and carbohydrates (Delpeuch, 1994) [2]. Weaning is a nutritional aggression for infants who are used to feeding exclusively on breast milk. It is at this period of the child's life that the various signs of protein-energy malnutrition appear (Trêche, 2000) [3]. During the weaning period, the mother introduces into the child's diet porridge which is generally based on starch products. These porridges are prepared from the flour.The quality of infant flours during this period is therefore of great importance. In Africa, pendant weaning, mothers feed their children with traditional porridge from simple or compound flours from cereals, tubers that are high in carbohydrates and low in protein. These foods are unable to cover all of the child's nutritional needs. Good quality infant flours do exist on the market, but they are imported and highly expensive industrial products. As a result, they are not accessible to generally poor mothers. FAO and WHO recommend that complementary foods be confectionery from locally available and accessible products of nutritional quality to meet the nutritional needs of children (FAO/WHO, 2009) [4]. However, the study of the nutritional value of complementary foods in Côte d'Ivoire is still mostly consumed in the Upper Sassandra region. Therefore, knowledge of their biochemical characteristics and the evaluation of their health quality would prove essential to their recovery. To achieve this, we will identify the most widely used complementary foods in this region and conduct their physical-chemical and microbiological analysis.

II. MATERIAL AND METHODS

2.1. Raw materials

Two varieties of sweet potato (*Ipomoea batatas*) (white and pink) and one variety of taro (*Colocasia esculenta*) were used for starch production. These three varieties were purchased at the various markets of Daloa, Issia, Vavoua and Zoukougbeu.

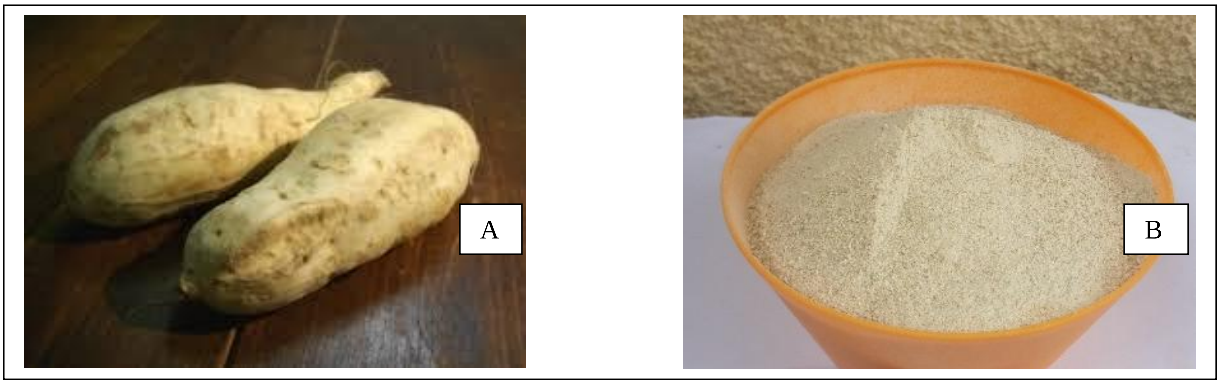


Figure 1 : Figure 2:White potato (A) and itsstarch (B)

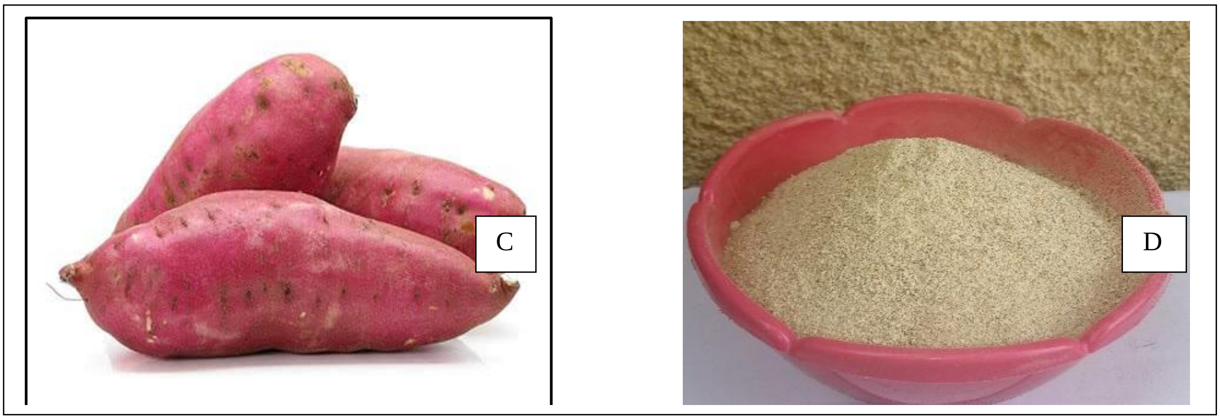


Figure 2 : Pink potato (C) and its starch (D)

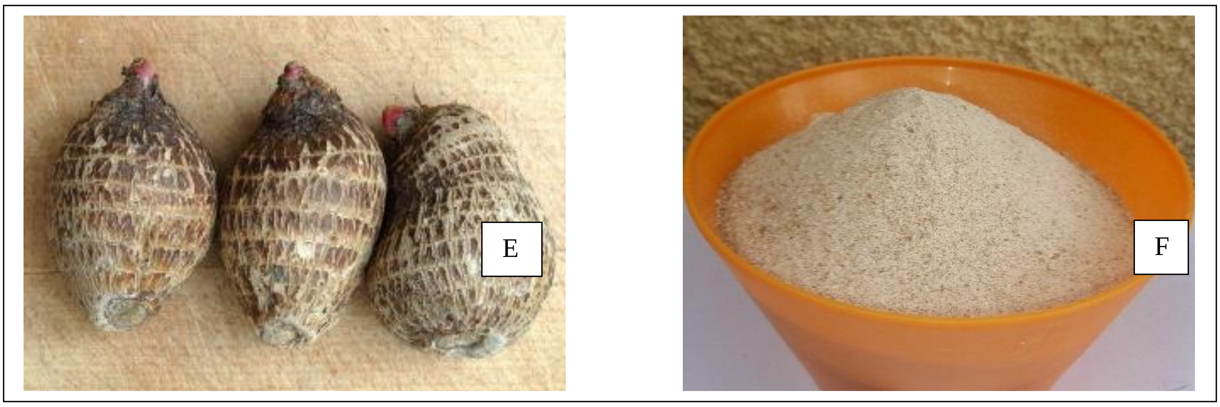


Figure 3 : Figure 4: Taro (E) and its starch(F)

2.2. Nutritional Survey

2.2.1. Study and Sampling Area

The study was conducted in four locations in the Upper Sassandra region of central west Côte d'Ivoire. These localities are Daloa, Issia, Vavoua and Zoukougbeu. Four hundred (400) mother-child couples, with children ranging in age from 6 to 24 months, were enrolled in the survey, with 100 mother-child couples per locality.

2.2.2 Preparing starches

The potato and taro tubers were washed to remove any foreign elements and then peeled with a knife previously washed, sliced and washed in a vat of water. The slices were then pre-cooked in a saucepan containing boiling water over a gas fire. After 5 minutes of pre-cooking, the cooking water was removed and the tuber slices were then dried in the steamer at 65°C for 5 days and then crushed manually and the resulting starch was sifted with a sieve 300 µm in diameter.

2.3. Characteristics and preparation of porridge from potato and taro starches

2.3.1 Preparing porridge made from potato starch and taro

In an aluminum saucepan, the proportions of 10, 20, 30 and 40 g of potato and taro starches were released into 100 ml of water. We then let them boil for about ten minutes (Mouquet, 1998) [5].

2.3.2 Physicochemical characterization of starches

The dry matter was determined by drying at the 105°C steam for 24 hours (AOAC, 1990) [6]. Carbohydrate content was calculated by difference (Soro *et al.*, 2013) [7]. The method used to determine the protein is that of KJELDAHL (AOAC, 1990) [6]. The lipid content was determined using the standardized Soxhlet/hexane method (AOAC, 1990) [6]. The ash content was determined by incineration in a 500-degree mitt oven for 5 hours (AOAC, 1990) [6]. Magnesium, potassium, calcium and iron levels are measured by atomic absorption spectrometry, Perkin-Elmer, Model 110 (B.I.P.E.A, 1976) [8].

2.3.3. Characterization of weaning porridge

2.3.3.1 Fluidity of weaning porridge

The consistency of porridge is measured at the flow rate using the BOSTWICK consistometer (Vieu et Traoré, 2001) [9].

2.3.3.2 Energy density of weaning porridge

Energy density (ED) is calculated based on carbohydrate, fat and protein content and energy equivalency based on Atwater's (1986) caloric coefficients [10].

2.4. Microbiological analysis

The PCA (Plate Count Agar), MRS (De Man, Rogosa, Sharpe) and DCL (Deoxy-cholate Citrate Lactose) media were used (Bio-Rad, Ca, USA), respectively, to assess total aerobic mesophilic flora, lactic bacteria and fecal coliforms. The count was conducted after 48 hours of incubation at 37°C of prepared porridge.

2.5. Statistical analysis

The collected data was entered into a table using 2013 Microsoft Excel software. These data were represented as a standard deviation average and as a percentage.

III. RESULTS

3.1. Analysis of survey data

3.1.1. Types of porridge offered to children and ages of introduction of porridge

This survey found that porridge is the most widely used (80%) as a supplement to breast milk by mothers in the Upper Sassandra region. Next came mashed potatoes (13%), cookies (5%) and juices (2%) (Figure 4). For local products used to prepare local porridge, cereals come first (48%), followed by roots and tubers (30%), dairy products (8%), meats, fish and eggs (MFE) (6%), fruits and vegetables (5%) and legumes (3%) (Figure 5). As for the age of introduction of breast milk supplement foods, 62% of mothers introduce them before six (06) months, 36% from six (06) months to one year and 2% after one year (Figure 6).

3.1.2 Frequency of daily consumption of porridge

Table I shows the frequency of daily consumption of porridge. It shows that 59% of mothers give porridge two (2) times a day compared to 28% three (3) times a day. While a small proportion of mothers (10%) gives their child four (4) times a day of porridge.

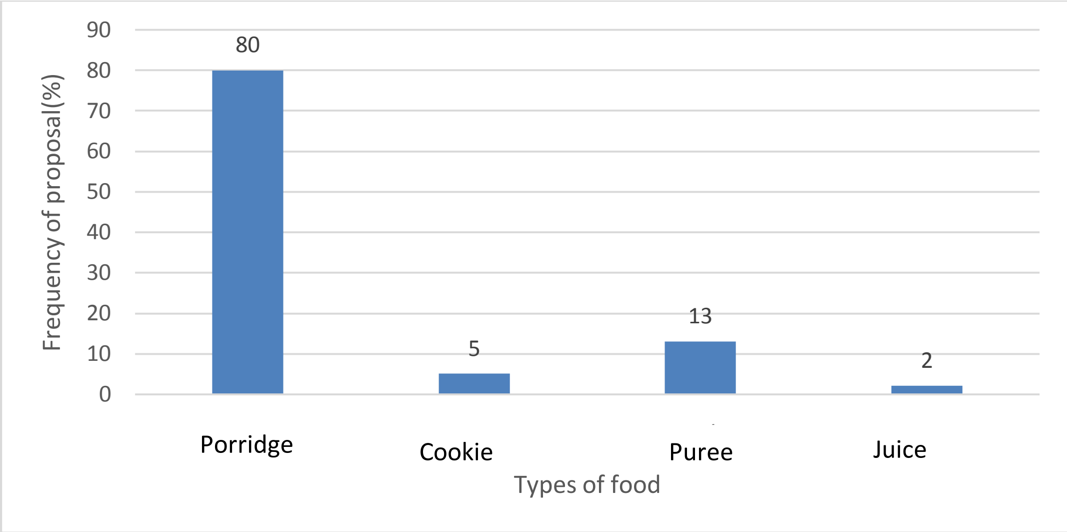
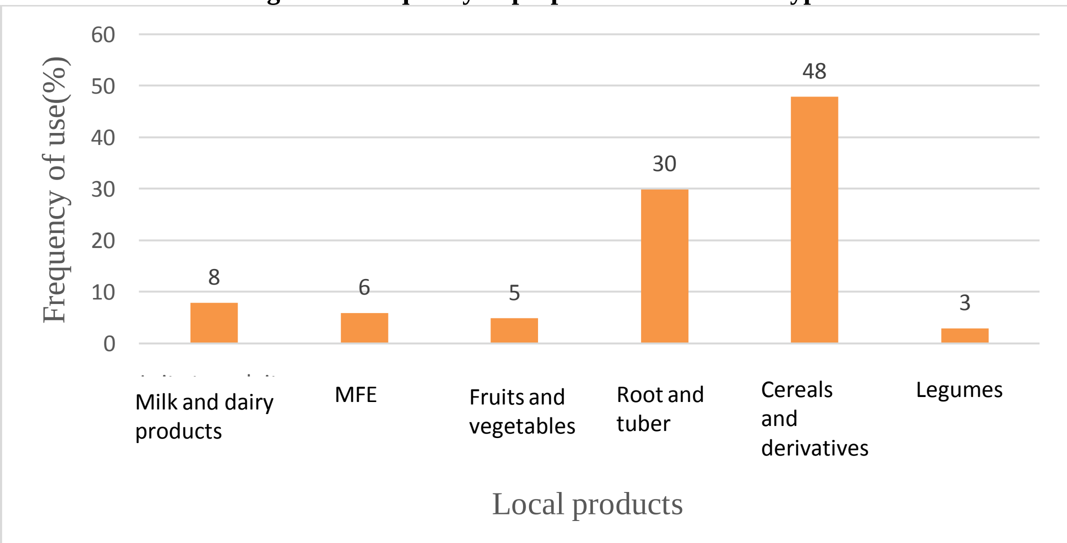


Figure 4: Frequency of proposal based on food type



MFE: Meat, fish and eggs

Figure 5: Frequency of use of local products in the preparation of porridge

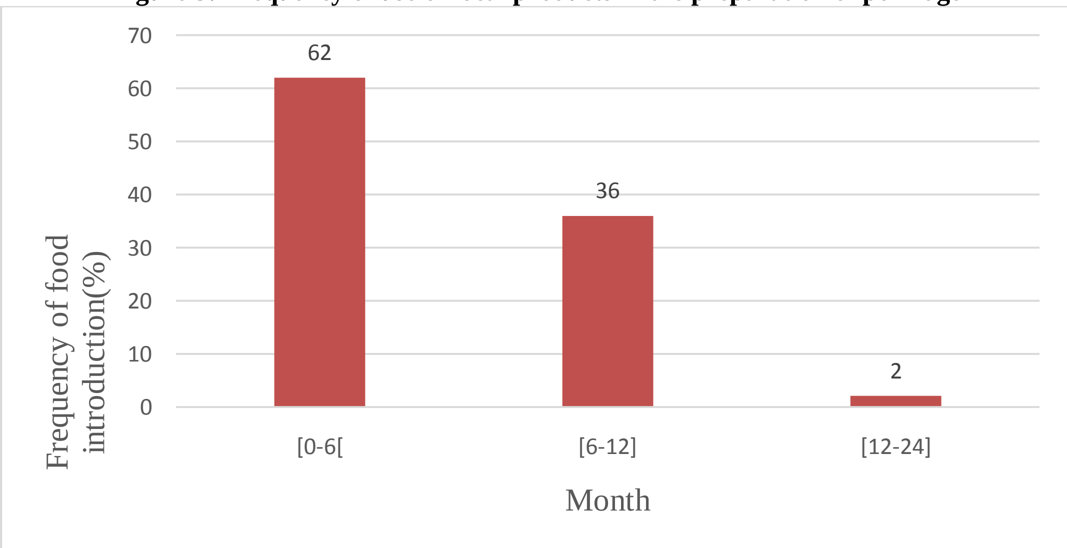


Figure 6: Frequency of food introduction depending on the month.

Table I: Frequency of daily consumption of porridge

Frequencies	Staffing	Percentage (%)
1	12	3
2	236	59
3	112	28
4	40	10

3.2 Nutritional composition of potato and taro starches

3.2.1. Macromolecular composition

The macromolecular composition of potato and taro starches is presented in Table II. The results indicate that the carbohydrate content of these flours is high. They range from 86.45 ± 2.25% (white potato) to 82.34 ± 3.53% (Taro). Protein levels range from 2.975 ± 0.4% (white potato) to 8.9 ± 0.02 % (taro). On the other hand, the fat content is very low (0.87 ± 0.02% (taro)-2.25 ± 0.09 % (pink potato)). Dry matter of these starches ranges from 87.26 ± 3.05% (pink potato) to 89.08 ± 3.6% (taro). The ash content is 2.36 ±0.16% in the white potato, 2.46 ±0.02% in the pink potato and 2.48 ±0.02% in the taro.

3.2.2. Mineral composition

The mineral composition of the three starches is recorded in Table III. Phosphorus levels range from 12.4 ± 1.20 mg/100 g of DM (taro) and 27±1.32 mg/100 g of DM (red potato). White potato starch contains 83.7 ± 1.25 mg / 100g DMin potassium, 83.2±1.26 mg / 100g DMin calcium, 11.8 ±0.2 mg / 100g DM in magnesium and 0.011±0.002 mg / 100g DMin iron. Regarding pink potato starch, it contains 84.3 ±1.50 mg / 100g DM inpotassium, 82.3±2.0 mg / 100g DM in calcium, 10.8±1.2 mg / 100g DM in magnesium and 0.01±0.003 mg / 100g DMin iron. As for taro starch, it gives levels of 0.1±0.13 mg / 100g DMin potassium, 160±1.5 mg / 100g DMin calcium, 0.2 ±0.14 mg / 100g DMin magnesium and 1.64 ±0.02 mg / 100g DM in iron.

Table II: Chemical composition of sweet potato (white and pink) and taro

Nutrients (%)	White Potato	Pink potato	Taro
Dry matters	88.50 ± 3.5	87.26 ± 3.05	89.08 ± 3.6
Carbohydrates	86.45 ± 2.25	84.95 ± 2.36	82.34 ± 3.53
Proteins	2.975± 0.4	3.062± 0.5	0.74±0.06
Fats	1.56± 0.01	2.25± 0.09	0.87± 0.02
Ashes	2.36± 0.16	2.46± 0.02	2.48± 0.02

Table III: Mineral content of sweet potato (white and pink) and taro

Minerals (mg)	White potato	Pink potato	Taro
Potassium	83.7 ± 1.25	84.3± 1.50	0.1± 0.13
Calcium	83.2± 1.26	82.3± 2.0	160± 1.5
Phosphorus	23± 1.41	27± 1.32	12.4± 1.20
Magnesium	11.8± 0.2	10.8± 1.2	0.2± 0.14
Iron	0.011± 0.002	0.01± 0.003	1.64± 0.02

3.3. Health quality of starches

The germs that have been counted in sweet potato starches (white and pink) and taro are total flora, fecal coliforms, yeasts and molds and *Escherichia coli* (Table IV). The results indicate their ratio is in these starches well below the permitted standards: total flora (10^3 to 10^4 germs / g <10^5), fecal coliforms (2 to 3 germs <10), yeasts and molds (10 to 20 germs <10^3), *Escherichia coli* (1 to 3 germs <10). No salmonella was found in the three different starches**.**

Table IV: Counting germs in leather flour

Germs counted	White potato (germes/g)	Pink Potato (germs/g)	Taro (germs/g)	Criteria (FAO/OMS) (germes/g)
Total flora	10^4	10^3	10^4	10^5
Fecal Coliforms	6	3	2	10^2
Escherichia .coli	2	3	1	10
Yeasts and Molds	10	20	14	10^3
Salmonella	Absent	Absent	Absent	Absent

3.4. Physicochemical characteristics of weaning porridge

Table V indicates that the physical-chemical characteristics of porridge prepared from sweet potato starches (white and pink) and taro. For example, the dry matter of white potato ranges from 4.2% to 16.1% when it is increased from 10g of porridge to 40g of porridge, compared to 4.4% to 16.2% for pink potato and from 4.9% to 17.9% for taro. Fluidities seem to decrease when the amount of porridge from these tubers is increased. Indeed, they are 102 mm/30 s to 00 mm/30s for the white potato from 10 g to 40 g of porridge against 100 mm/30s to 00 mm/30 s for the pink potato and from 95 mm/30 s to 00 mm/30 s for the taro. The energy densities of these porridges are quite interesting. They go from 16.8 Kcal/100 ml to 64.4 Kcal/100 ml for white potato versus 17.6 Kcal/100 ml to 64.8 Kcal/100 ml for pink potato and 19.6 Kcal/100 ml to 71.6 Kcal/100 ml for taro.

Table V: Physical-chemical characteristics of sweet potato starch porridge (white, pink) and taro

Amount of starch(g)	White potato	Pink potato	Taro
10	DM : 4.2 % Fluidity : 102 mm/30 s Protein : 2.975 % ED : 16.8 Kcal/100 mL	DM : 4.4 % Fluidity : 100 mm/30s Protein : 3.062 % ED : 17.6 Kcal /100 mL	DM : 4.9 % Fluidity : 95mm/30s Protein :8.9 % ED : 19.6 Kcal/100 mL
20	DM : 8.1 % Fluidity : 73 mm/30 s Protein :2.975 % ED : 32,4 Kcal/100 mL	DM : 8.3 % Fluidity : 72 mm/30 s Protein :3.062 % ED : 33.2 Kcal/100 mL	DM : 9.1 % Fluidity : 69 mm/30s Protein :8.9 % ED : 36.4 Kcal/100 mL
30	DM : 12.5 % Fluidity : 11 mm/30s Protein :2.975 % ED : 50 Kcal / 100 mL	DM : 12,7 % Fluidity : 10 mm /30s Protein : 3.062 % ED : 50.8 Kcal/100 mL	DM : 13.7 % Fluidity : 00mm / 30s Protein : 8.9 % ED : 54 Kcal/100 mL
40	MS : 16.1 % Fluidity : 00 mm/30s Protein : 2.975 % ED : 64.4 Kcal/100 mL	DM : 16.2 % Fluidity : 00 mm /30s Protein:3.062 % ED : 64.8 Kcal/100 mL	DM : 17.9 % Fluidity : 00 mm / 30s Protein : 8.9 % ED : 71.6 Kcal /100 mL

DM: Dry Matter, ED: Energy Density

IV. DISCUSSION

This study was conducted to assess the nutritional potential of breast milk supplement foods in children aged 6 to 24 months in the Upper Sassandra region. The target population survey shows that most mothers (80%) local porridge as a supplement to breast milk. Traoré *et al*., (2005) [11] also showed in their study that the most commonly used staple food is local porridge. However, other types of complementary foods such as mashed potatoes (13%), biscuit (5%) and juices (2%) are used but at very low proportions. Local products used in the preparation of porridge for infants and young children are cereal-based (48%) tubers (30%). Dairy products, legumes, fruits and vegetables and Meat-Fish-Eggs are very little used in the preparation of infant porridge due to their high cost. The frequency of daily consumption of local porridge by children is low. In fact, 59% of children received porridge twice a day and 28% received 3 times a day. This low daily consumption therefore cannot cover the nutritional needs of these young children. Other authors such as Trèche (2002) and Kasole *et al*., (2013) [12] [13] have also shown that local porridges are used with a low daily frequency. This very precarious and inadequate practice of mothers seems to be the result of the lack of information on good complementary feeding practices and the lack of financial resources for most households. On the other hand, many mothers (62%) introduce complementary foods before 6 months. However, WHO has recommended that complementary foods should not be introduced into the diet of young children until the 6th month (WHO/UNICEF, 2003) [14]. This is a lack of nutritional education on the part of mothers. This could then have a negative impact on breast milk production. The protein content of the flours in these tubers is low (2,975 - 0.4 - 8.9 - 0.02 g /100 g). However, they are no less negligible in order to help meet the daily protein needs of these children. These values corroborate those between 2.6 and 3.2 g/100 g obtained by Martin (1984) [15] in the flour of these same tubers. Taro contains the highest protein content (8.9 - 0.02%). This value is higher than the 4% reported by (Onwueme *et al*, 1994) [16]. In addition, these three different flours contain very little fat (0.87 - 0.02 - 2.25 - 0.09%). These results give these tubers a better nutritional quality because the fat consumed in very large quantities could be a source of cardiovascular disease (Deprez *et al*., 2001) [17]. These values are similar to those reported by Van (2000) and Ahmed et al. (2010) [18] [19]. The same is true for their ash content (2.36 - 0.16 - 2.48 - 0.02%). However, these resulting levels reflect a significant mineral wealth of these three flours.

These results are corroborated with those obtained by Viviane *et al*. (2011) [20] (2 %) and Soro (2013) [7] (1.88 - 0.06%). On the other hand, their carbohydrate content is very high (82.34 per cent and 86.45 per cent). Similar values were reported by Bouwkamp (1985) [21]. He found levels between 75 and 90% in the same tubers. This remarkable carbohydrate richness could provide the bulk of the body's energy (Atwater, 1986) [10]. The results also revealed very high levels of dry matter in these different flours. These results show that these flours contain very little water. This characteristic of these flours could allow them to be stored efficiently for a long time without the risk of microbial proliferation. According to Soro (2013) [7], microorganisms develop more easily in foods with high water content. In addition, porridge prepared with these three flours is free of pathogenic germs that can harm the health of infants. Such porridge cannot cause diarrhea (Mouquet, 1998) [5]. Based on the microbiological standards for infant cooking and instant flours recommended by FAO/WHO (1991) [22], these three infant flours have satisfactory microbiological quality.

V. CONCLUSION

Local porridge produced from white potato, pink potato and taro is low in protein and lipid materials. This infant flour also provides insufficient mineral content to meet the child's physiological needs. From a microbiological point of view, this supplemental food is acceptable because it contains very few pathogenic germs that can cause toxi-infections and diarrhea for children. Prepared as porridge from potato and taro starches, it has a fluid and suitable consistency for the infant. However, it is not balanced into macronutrients and micronutrients to cover the nutritional needs of children on its own.

REFERENCES

[1]. Akre J., (1989). L'alimentation infantile : bases physiologiques. *Bulletin de l'Organisation mondiale de la santé*, suppl. 67 : 1-112.

[2]. Delpeuch F. (1994). «L'alimentation de complément du jeune enfant», Orstom éditions.39-46.

[3]. Trêche S. (2000). Activités du 2ème atelier international. Voies alimentaires d'amélioration des situations des situations nutritionnelles en Afrique de l'Ouest. Ouagadougou, Burkina Faso. 745-773.

[4]. FAO/OMS (2009). Programme mixte FAO/OMS sur les normes alimentaires. Commission du Codex Alimentarius, 32ème session Rome (Italie). Rapport de la 30ème session du comité du codex sur la nutrition et les aliments diététiques ou de régime. Le Cap (Afrique du Sud) 3-7 Novembre 2008. 1-223.

[5]. Mouquet C. (1998). Les farines infantiles. Bulletin du réseau Technologique et Partenariat en Agro-alimentation (TPA), numéro du 15 Mai 1998, 9-20.

[6]. AOAC.(1990). *Official Methods of Analysis* (Vol. 2, 15th ed). Washington, DC: Association of Official Analytical Chemists.

[7]. Soro S., Konan G., Elleingand E., N'guessan D.&Koffi E. (2013).Formulation d'aliments infantiles à base de farines d'igname enrichies au soja.

[8]. BIPEA, (1976). Recueil des méthodes d'analyses des communautés européennes. Bureau interprofessionnel d'études analytiques: Gennevilliers. France ; 140 p.

[9]. Vieu M.C. & Traoré T.S. (2001). Effects of energy density and sweetness of gruels on Burkinabe infant energy intakes in free living condition. *Journal of Food Sciences and Nutrition*, 52: 213-218.

[10]. Atwater, (1986). The American Journal of Clinical Nutrition, Volume 45, Issue 5, 1 May 1987, 896-897.

[11]. Traoré T., Vieu M.C., Traoré S.A. & Trèche S.(2005). Effets de la durée de la période d'accoutumance sur les ingérés énergétiques à partir de bouillies de faible et de hautes densités énergétiques chez les nourrissons Burkinabè vivant en milieu naturel. *Appetite*,2-5.

[12]. Trèche S. (2002). Complementary foods in developing countries: importance, required characteristics, constraints and potential strategies for improvement. In Kolsteren P, Hoerée T, Perez- Cueto eds: Proceedings of the International Colloquium promoting growth and development of under-fives. Antwerpen: ITG Press: 132-148.

[13]. Kasole T.L., Mulangu A.M., Muganza A.N., Ilunga P.M, Wakam G.K., Kitengewa F.M. (2013). Allaitement maternel et diversification alimentaire à Lubumbashi (RDC) : besoin urgent d'éducation des mères pour le changement des habitudes. *African Medical Journal*, 8-12.

[14]. OMS/UNICEF (2003). Recommandations relatives à l'allaitement maternel exclusif et l'alimentation complémentaire des jeunes enfants dans les pays en développement. OMS: Genève; 130-131.

[15]. Martin F.W. (1984). Techniques and problems in small scale production of flour from sweet potato. *J Ag Univ Puerto Rico*, 423-432.

[16]. Onwueme I. & Charles W.B. (1994). *Cultivation of cocoyam*. In: Tropical root and tuber crops. Production, perspectives and future prospects. FAO Plant Production and Protection Paper 126, Rome, 139-161.

[17]. Déprez S., Mila I., Huneau J., Tomé D. & Scalbert A. (2001). Transport of proanthocyanidin dimer and polymer across monolayers of human intestinal epithelial Caco-2 cells. *Antiox Redox Signal*, 3: 957-967.

[18]. Van Hal M.V. (2000). Quality of sweet potato flour during processing and storage.*Journal of Food Reviews International*, 1 - 37.

[19]. Ahmed M., Akter M.S., Lee J.C. & Eun J.B. (2010).Encapsulation by spray drying of bioactive components, physicochemical and morphological properties from purple sweet potato.*LWT - Food Science and Technology*, 43: 1307-1312.

[20]. Viviane. J. Zannou Tchoko, Kouamé Guy Marcel Bouaffou, Koffi Gustave Brou André Konan, (2011). Bulletin de la Société Royale des Sciences de Liège, 80 : 748-758.

[21]. Bouwkamp J.C.(1985).Sweet Potato Products: A natural resource for the tropics (Part II).*Library of Congress Cataloging, Florida*, 137-259.

[22]. FAO / OMS (1991). Normes de codex alimentarius pour les aliments traités à base de céréales pour nourrissons et enfants en bas âge (CODEX STAN 74-1981). Programme mixte FAO/OMS sur les normes alimentaires, Rome.

****Corresponding author: Gnahé Dago André***
Agro-valorizationLaboratory, Agroforestry Department, Jean Lorougnon GUEDE University, P.O. Box 150 Daloa, Cote d'Ivoire