EAS Journal of Nutrition and Food Sciences
Abbreviated Key Title: EAS J Nutr Food Sci
ISSN: 2663-1873 (Print) & ISSN: 2663-7308 (Online)
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-2 | Issue-2 | Mar-Apr; 2020 | DOI: 10.36349/easjnfs.2020.v02i02.003

Research Article

Physicochemical and nutritive properties of by-products flours from cashew (*Anacardium occidentale*) and mango (*Mangifera indica*) for ruminants feeding in Poro region (*Northern Côte d'Ivoire*)

Touré Abdoulaye[1,2*], Zoro Armel Fabrice[1,3], Touré Naka[1,4], Sall Fatou[1], Soro Yadé Réné[3] & Coulibaly Adama[1,2]

[1]Laboratoire de Biotechnologie et Valorisation des Agroressources et Substances Naturelles, UFR Sciences Biologiques, Université Peleforo Gon Coulibaly, BP 1328 Korhogo, Côte d'Ivoire.
[2]Laboratoire de Pharmacodynamie-Biochimie, UFR Biosciences, Université Félix Houphouët-Boigny, 22 BP 582 Abidjan 22, Côte d'Ivoire.
[3]Laboratoire de Biotechnologie, UFR of Biosciences, Université Felix Houphouët-Boigny, 22 BP 582 Abidjan 22, Côte d'Ivoire.
[4]Laboratoire de Biocatalyse et Bioprocédé, UFR Science et Technologie des Aliments, Université Nangui Abrogoua, 02 BP 801 Abidjan 02, Côte d'Ivoire.

Article History
Received: 24.03.2020
Accepted: 20.04.2020
Published: 25.04.2020

Journal homepage:
https://www.easpublisher.com/easjnfs

Quick Response Code

Abstract: Agricultural and agro-industrial by-products are not valued enough in Northern Côte d'Ivoire where farm animals feeding is a major problem. This work focuses on study of physicochemical and nutritive properties of flours of cashew apple, mango peels and mango seed kernel in order to use them for ruminants feeding. Results of analysis show that all flours studied have an acid pH between 3.7 ± 0.14 and 4.30 ± 0.38. Moisture of different flours are low values and therefore high levels of dry matter varying from 88.09 ± 0.86 to 89.47 ± 0.26 %. Cashew apple flour possess high level of ash with 5.67 ± 0.85 % while those of mango seed kernel content lowest level with 1.87 ± 0.45 %. For minerals composition, mango peels and cashew apple flours have high concentrations respectively of calcium (99.29 ± 1.47 mg/100g) and phosphorus (136.59 ± 0.75 mg/100g). According to organic compounds, these three flours have high levels of carbohydrates between 60.59 ± 0.55 and 63.34 ± 0.35 %. Their lipids are low concentrations varying from 3.71 ± 0.45 to 5.05 ± 0.33 %. All flours have intermediate proteins contents between 18.45 ± 0.71 and 19.17 ± 0.41 %. Finally, these flours are a good source of energy with values from 297.05 ± 2.05 to 311.69 ± 4.05 Kcal/100g of dry matter. These results suggest that flours of cashew apple, mango peels and mango seed kernel can be combined in formulation of livestock feed for ruminants.

Keywords: Cashew, mango, by-products flours, nutritive properties, feeding of ruminants, Northern Côte d'Ivoire.

INTRODUCTION

According to the Food and Agriculture Organization, the annual consumption of meat in Côte d'Ivoire is only 40 % covered with 2 million of cattle and 3 million of sheep and goats (FAO, 2016). Thus, to reduce the import of ruminants in particular, this country has decided to develop its farm animals production. Also, ruminant farming is often a source of conflict between breeders and farmers in North of Côte d'Ivoire because of their diet (Ouattara, 2014). So, in African countries of southern Sahara, they are many constraints for breeding farm animals such as the fodder and nutritional deficit of dries seasons. This situation is a consequence of the bad management of pastures, the high cost of livestock feed and the low valuation of agricultural and agro-industrial by-products (Mopaté & Koussou, 2003; MRA, 2007; Drabo, 2007; Kiendrébéogo, 2008; Mopaté et *al*., 2011). The use of these by-products, not consumed by humans, for animals feeding would make it possible to enhance their value, particularly for ruminants (Preston, 1987; Bosma *et al*., 2004). This work focuses on cashew apple, mango peels and seed kernel, an agricultural and agro-industrial by-products of North of Côte d'Ivoire. Its objective is to study the physicochemical and nutritive properties of these by-products flours in order to use them for production of livestock feed for ruminants.

MATERIALS AND METHODS

Biological material

The biological material consists of cashew (*Anacardium occidentale*) apple and mango (*Mangifera indica*) variety "Kent" peels and seed kernel collected in the Poro region (North of Côte d'Ivoire).

Production of by-products flours

***Corresponding Author:** Touré Abdoulaye

Flour of cashew apple

The cashew apples were collected in a farm around Peleforo Gon Coulibaly University. These apples were removed from the nuts and then pressed to extract the juice. The cashew apple cakes obtained were sun dried for four weeks. The dried cakes were crushed and the flour obtained was put into container for storage until its use.

Figure 1: Dried cake of cashew apple

Flour of peels and seed kernel of mango

The mango peels and seed were collected from the mango dryer factory of agricultural cooperative company namely "Gninnagnon" in Korhogo (North of Côte d'Ivoire. The kernel of mango was separated from the hulls of the seed. The peelings and almonds were then sun dried for a week. After drying, these by-products of mango were crushed separately and the flours were then put into container for storage until their use.

a) Mango peels b) Mango seed

Figure 2: By-products of mango

Analysis of by-products flours

Proximate analysis of various flours was performed using official methods (AOAC, 1990).

Determination of physicochemical parameters

To determine pH, 10 g of each flour sample was homogenized into 100 ml of distilled water before filtered the mixture through Whatman No.4 filter paper. The pH value was recorded using pH-meter (Hanna, Spain). Titratable acidity of flours was determined by titrated 10 ml of above filtrate by sodium hydroxide (NaOH, 0.1N). The moisture content of flours was obtained on dry matter basis by the difference of weight before and after drying 10 g of sample in an oven (Memmert, Germany) at 105°C until constant weight. Ash fraction was determined by the incineration of each flour sample (5 g) in a muffle furnace (Pyrolabo, France) at 550°C for 12 hours. The percentage residue weight was expressed as ash content on dry matter basis.

Determination of nutritive properties

For organic compounds, proteins were obtained through the Kjeldhal method and the lipid content was determined by Soxhlet extraction using hexane as solvent. Carbohydrates and calorific value were calculated using the following formula (FAO, 2002):

Carbohydrates = 100 – (% moisture + % proteins + % lipids + % ash).

Calorific value = (% proteins x 2.44) + (% carbohydrates x 3.57) + (% lipids x 8.37).

The results of protein, lipid and carbohydrate contents were expressed on dry matter basis.

The mineral (calcium and phosphorus) content was estimated by incineration of flour sample (5 g) in a muffle furnace (Pyrolabo, France). The ash obtained was dissolved in 5 ml of mixture of chloride acid and nitric acid (HCl/HNO3) and analyzed using the atomic absorption spectrophotometer (AAS model, SP9).

Statistical analysis

All the analyses were performed in triplicate and data were analyzed using Excel and Statistica 7.1 (StatSoft). Differences between means were evaluated by Duncan's test. Statistical significant difference was stated at $p < 0.05$.

RESULTS

Physicochemical parameters

Table 1 presents the physicochemical parameters of the flours of cashew apple, mango peels and mango kernel. The results significantly different ($p < 0.05$) show that all the by-product flours studied have an acid pH between 3.7 ± 0.14 and 4.30 ± 0.38. Cashew apple and mango peels with respectively 3.80 ± 0.75 and 3.7 ± 0.14 have the lowest pH while the highest have been recorded at 4.30 ± 0.38 by mango kernel. The titratable acidities of flours of cashew apple and mango kernel reveal the low values respectively of 3.30 ± 0.75 and 2.80 ± 0.38 % than those of mango peels with 5.20 ± 0.14 %. The moisture of different flours gave low values between 10.53 ± 0.35 and 11.91 ± 0.15 % and therefore high levels of dry matter varying from 88.09 ± 0.86 to 89.47 ± 0.26 %. The ash contents of flours oscille between 5.67 ± 0.85 % and 1.87 ± 0.45 %.

Table 1: Physicochemical properties of flours

	Cashew apple	Mango peels	Mango kernel
pH	3.80 ± 0.75^{a}	3.7 ± 0.14^{a}	4.30 ± 0.38^{b}
Titratable acidity (%)	3.30 ± 0.75^{b}	5.20 ± 0.14^{a}	2.80 ± 0.38^{b}
Moisture (%)	10.61 ± 0.46^{b}	10.53 ± 0.35^{b}	11.91 ± 0.15^{a}
Dry matter %	89.39 ± 0.76^{c}	89.47 ± 0.26^{c}	88.09 ± 0.86^{b}
Ash (%)	5.67 ± 0.85^{a}	3.11 ± 0.43^{b}	1.87 ± 0.45^{d}

Data are represented as Means±SD (n = 3). Means in the lines with no common superscript differ significantly ($p < 0.05$)

Nutritive properties

Nutritive values significantly different ($p < 0.05$) of the flours of cashew apple, mango peels and mango kernel are present in table 2. For minerals composition, mango peels and cashew apple flours have the high concentrations respectively of calcium (99.29 ± 1.47 mg/100g of dry matter) and phosphorus (136.59 ± 0.75 mg/100g of dry matter). According to organic compounds, these three flours have a high levels of carbohydrates between 60.59 ± 0.55 and 63.34 ± 0.35 %. Their lipids show low concentrations varying from 3.71 ± 0.45 to 5.05 ± 0.33 %. The flours have intermediate contents of proteins between 18.45 ± 0.71 and 19.17 ± 0.41 %. Finally, these flours are a good source of energy with values from 297.05 ± 2.05 to 311.69 ± 4.05 Kcal/100g of dry matter.

Table 2: Nutritive properties of flours

	Cashew apple	Mango peels	Mango kernel
Calcium (mg/100g)	80.14 ± 0.75^{a}	99.29 ± 1.47^{a}	72.83 ± 0.83^{a}
Phosphorus (mg/100g)	136.59 ± 0.75^{a}	92.75 ± 1.47^{a}	95.57 ± 0.83^{a}
Proteins (%)	19.03 ± 0.25^{a}	18.45 ± 0.71^{a}	19.17 ± 0.41^{a}
Lipids (%)	4.10 ± 0.38^{b}	5.05 ± 0.33^{a}	3.71 ± 0.45^{b}
Carbohydrates (%)	60.59 ± 0.55^{c}	62.86 ± 0.15^{b}	63.34 ± 0.35^{b}
Calorific energy (Kcal/100g)	297.05 ± 2.05^{d}	311.69 ± 4.05^{b}	303.95 ± 3.75^{c}

Data are represented as Means±SD (n = 3). Means in the lines with no common superscript differ significantly ($p < 0.05$)

DISCUSSION

Physicochemical analysis revealed that the flours of cashew apple, mango peels and mango kernel have acid pH. Their pH were slightly lower than those of maize flour (4.51 ± 0.06) studied by Touré et *al.* (2019). Also, the three flours possess highest dry matter contents comparatively to *Panicum maximum* (26.90 %) and *Pennisetum purpureum* (21.90 %), two green fodder studied by Ettian et *al.* (2018). The high dry matter content of the flours could be used like fodder or grass in the feeding of the ruminants. In fact, this dry matter rate of flours of cashew apple, mango peeling and mango kernel is relatively higher than that of the grass and fodder which are traditionally the base of ruminants feeding (INRA, 2010). For ash, the cashew apple flour possess the high level with 5.67 ± 0.85 % while those of mango kernel content the lowest level with 1.87 ± 0.45 %. The mango peels flour (3.11 ± 0.43 %) give the intermediate ash content. The cashew apple and mango peeling flours have then ash contents higher than cereals (<2%) and approximatively close to those of tubers (2 to 6%) (Antia et *al.*, 2006). The high ash content of cashew apple flour would be an indicator of their mineral elements richness (Nielsen & Harbers, 2003). Minerals are the major minerals that go into the formation of bones, teeth and muscle contraction as well as the production of energy. With regard to mineral composition, the cashew apple flour and mango peels flour are essential sources of calcium and phosphorus. The contents of calcium of these two flour are higher than those of leaves of *Abelmoschus esculentus* (Ca = 75.37 mg/100g) studied by Zoro et *al.* (2015).

Phosphorus content of these leaves (P = 108.04 mg/100g) is lower than those of cashew apple flour and higher than mango peels flour. Also, concentrations of calcium and phosphorus of *Panicum maximum* (Ca = 430 mg/100g; P = 370 mg/100g) and *Pennisetum purpureum* (Ca = 370 mg/100g; 290 mg/100g) studied by Ettian et *al*. (2018) are very highest than those of all flours of this study. Energy nutrients are used to produce the energy using by the animal. Carbohydrates provide most of this energy. The flours of cashew apple and mango peeling and kernel have carbohydrates contents lower than maize flour studied by Touré et *al*. (2019). However, their levels were very highly than carbohydrates contents of *Panicum maximum* (49.37 %) and *Pennisetum purpureum* (36.20 %) (Ettian et *al*., 2018). This richness in carbohydrates from these flours could provide the energy necessary for the various productions activities such growth, fattening, gestation and/or, lactation. Among the many plastic nutrients, there are proteins, minerals and lipids. Concerning proteins, the flours contents are approximatively identical and are highest than those of *Panicum maximum* (9.70 %) and *Pennisetum purpureum* (8.90 %) (Ettian et *al*., 2018) and maize flour (7.33 - 10.09 %) (Akaffou et *al*., 2018; Touré et *al*., 2019). The flours studied could be used as a source of protein in the livestock feed for the ruminants.

CONCLUSION

The physicochemical and nutritive characteristics of the flours of cashew apple, mango peels and mango almond were the subject of this study. The results show that these flours of the agricultural and agro-industrial by-products possess nutritive potentialities such carbohydrates, proteins, calcium, phosphorus and caloric energy. In addition, due to their high acidity and low moisture, their conservation is easier. In view of all these results, the flours of cashew apple, mango peels and mango almond can be combined in formulation of livestock feed for ruminants. In perspective, we plan to make cattle feed formulations and test their performance in the feeding of ruminants. Thus, we will be able to contribute to valorization of these agricultural and agro-industrial by-products and to reduction of the cost of cattle feed.

REFERENCES

1. FAO (2016). Revue des filières betail/viande & lait et des politiques qui les influencent en Côte d'Ivoire. 136p.
2. Ouattata Z. (2014). Alimentations des ruminants. 71p.
3. Mopaté L.Y & Koussou M.O (2003). L'élevage porcin, un élevage ignoré mais pourtant bien implanté dans les agro-systèmes ruraux et périurbains du Tchad. In : Jamin J. Y., Seyni Boukar L. et Floret C. (éditeurs scientifiques -CD-ROM), Actes du colloque « Savanes africaines : des espaces en mutations, des acteurs face à des nouveaux défis », Garoua, Cameroun, 27 - 31/05/2002, 9p.
4. MRA (2007). Diagnostic des filières bétail-viande et petits ruminants du Burkina Faso.Rapport final, AGRER-Statistika, 145 p.
5. Drabo (2007). Contraintes actuelles et perspectives de l'élevage porcin dans les zones intra et périurbains de Ouagadougou au Burkina Faso. Mémoire d'Ingénieur Zootechnicien. Institut polytechnique Rural de Formation et de Recherche Appliquée (IPR/IFRA) de Katibougou, Annexe de Bamako, Université du Mali, Bamako. 68p.
6. Kiendrébéogo T., Hamadou S., Mopaté L.Y. & Kaboré Z. C-Y. (2008). Typologie des élevages porcins urbains et périurbains de Bobo Dioulasso (Burkina Faso). Revue Africaine de Santé et des Productions Animales (RASPA), *6* (3-4): 205 - 212.
7. Mopaté L.Y., Kaboré Z. C-Y. & Facho B. (2011). Disponibilité et valeurs alimentaires des sons de riz, maïs et sorgho mobilisables dans l'alimentation des porcs à N'Djaména (Tchad). *Journal of Applied Biosiences*, 41: 2757 – 2764p.
8. Preston T.R. (1987). Porcs et volailles sous les tropiques : utilisation des ressources alimentaires locales. Centre technique de coopération agricole et rurale (CTA), Wageningen, Pays-Bas, 27 p.
9. Bosma R.H., Zongo L.C., Sané A., Zoungrana C. & Soudré A. (2004). Comparaison participatoire de trois méthodes d'engraissement des porcs dans les provinces du Sanguié et du Boulkiemdé au Burkina Faso. *Livestock Research for Rural Development*, Vol. 16, N°2, Février 2004.
10. AOAC (1990). Official methods of analysis. Association of Official Analytical Chemists Ed., Washington DC, 684p.
11. FAO (2002). Food energy-methods of analysis and conversion factors. FAO Ed, Rome, 97p.
12. Touré A., Oulaï S.F., Assoi S., Sakm A.H., Soro Y.R. & Coulibaly A. (2019). Physiocochemical, nutritional and techno-fonctional characterization of flours of millet (*Pennisetum glaucum*), maize (*Zea mays*) and soy (*Glycine max*) grown in the north of Ivory Coast. *International Journal of Biotech Trends and Technology*. *4*(9): 11-17.
13. Ettian M.K., Gbogouri G.A., Djenontin A.J. & Mensah G.A. (2018). Evaluation des apports nutritionels et énergétiques des fourrages verts dans l'alimentation des aulacodes (*Thyronomyces swinderianus*) en Côte d'Ivoire). *Revue Marocaine des Sciences Agronomique et Vétérinaire*. *6*(1): 99-109.
14. INRA (2010). Alimentation bovins, ovins et caprins – Besoins des animaux. 4p.
15. Antia B.S., Akpan E.J., Okon P.A. & Umoren I.U. (2006). Nutritive and antinutritive evaluation of sweet potato (Ipomea batatas) leaves. *Pakistan Journal of Nutrition*. 5: 166-168.

16. Nielsen S.S. & Harbers L.H. (2003). Ash analysis. In: Food analysis. Kluwer Academic Publisher, 3rd Ed, New York, pp. 103-111.
17. Zoro A.F., Zoué L.T., Adom N.J. & Niamké S.L. (2015). Effect of sun drying on nutritive and antioxidant properties of leafy vegetables consumed in western Côte d'Ivoire. *African Journal of Science and Research 4*(5): 24-31.
18. Akaffou F.A., Koffi D.M., Cissé M. & Niamké S.L. (2018). Physicochemical and functional properties of flours from three purple maize varieties named "Violet de Katiola" in Côte d'Ivoire. *Asian Food Science Journal*, *4*(4): 1-10.