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Research Paper

ANALYSIS OF CÔTE D'IVOIRE FISH FARM-MADE FEEDS: RAW MATERIALS, PRODUCTION AND PROXIMATE COMPOSITION

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Abstract

This study has been done by 54 fish farmers who mix owns their feed themselves in Côte d'Ivoire. Majority of raw materials; fish meal, rice bran, bran and wheat corn, defatted meal cashew nuts, white corn bran, corn meal, coconut cake, soya bean and cotton seed cake… used in fish farm-made formulation were byproducts locally available. The number of raw materials used in the fish feed formulas generally varies between 3 (31.5%) and 4 (25.9%) in the majority of cases. Food formulas used to produce feed is personal origin for most (40.7%).The majority of fish farm-made feeds were q low nutritional quality with an average crude protein content of 19.07 ± 6.28%, crude lipid content 7.52 ± 3.61%, ash 8.93 ± 2.69%, crude fiber 28.54 ± 13.48% energy 16.92 ± 1.17kJ/g, protein/energy ratio 11.15 ± 3.25mg/kJ. The average price of fish farm-made feeds was 0.19 ± 0.09 $/kg. The availability of raw materials, production and improved fish farm-made will enable the availability of quality feeds and contribute to increase of fish in Cote d'Ivoire.

Key words: Fish farm-made feed, raw material, biochemical composition, availability, Côte d'Ivoire.

INTRODUCTION

Fish contributes around 17% to the animal protein intake of the world population. This ratio even exceeds 50% in some humid tropical Africa [1]. While capture fisheries based on species that are presently exploited seem to have reached their natural limits [2-1], there is considerable potential to expand aquaculture in Africa in order to improve food security [3]. Intensive aquaculture requires a quality fish feeds [4]. However, the non-availability of quality feed on the farms constitutes an obstacle for the emergence of a profitable and lasting aquaculture in the countries economically weak. This situation

brings fish famer, to avoid very expensive and less available imported feed, formulated their feed. Thus, the use of fish farm-made feeds could reduce feed cost and improve fish production. Therefore fish farm-made feed is very crucial to the development and sustainability of aquaculture in reducing production cost [5-6].In Sub-Saharan Africa, fish farm-made feed is produced commercially and used only in Nigeria, Cameroon, Kenya, Zambia, Malawi and Uganda and Ghana. In Nigeria, largest fish producer in Sub-Saharan Africa, 70 percent of fish feed used is fish farm-made feeds [7]. In Côte d'Ivoire, the use of fish farm-made feed by fish farmers. It is evident from these works that this fish feeds undergoes no quality control on behalf of the official structures and that the quality varies from fish farming to another [8-9]. It is therefore incapable to ascertain the quality of this feed on the fish farming and their impact on the growth of fish and the productivity of the fish farms in Côte d'Ivoire. Indeed a good feed should satisfy the needs previously in nutrients established according to the species and the age of fish [10]. The objectives of this study were to evaluate the cost, availability and nutritional quality of fish farm-made feeds used by Ivoirian fish farmers. The assessment of the fish farm-made quality will permit to appreciate the nutritional value of this feed used and their contribution to the promotion of the aquaculture of Côte d'Ivoire.

1- MATERIALS AND METHODS

1-1 Protocol collection and sampling

An investigation has been driven in 13 main regions (Tonpki, Cavally, Agneby-Tiassa, District of Abidjan, South Comoe, Marahoue, Haut-Sassandra, Nawa, Gbêkê, Belier, Grands-ponts, The Me and Indenie-Djuablin) of fish production consisting of 33 Departments distributed through on the whole of Côte d'Ivoire excepted the north. A total 301 fish farms were visited The survey was realized on the fish farming using fish farm-made feeds. The investigation has been led with the help of a questionnaire elaborated with the software containing Sphinx 4.5 a set of questions on the farms, the costs of fish farm-made feeds and raw materials used, their availability, their frequencies of use and food formula used. These surveys have included direct interviews with fish farming managers, the visit of the surveyed fish farm, management documents were consulted and materials and fish farm-made were sampled, identified and labeled on fish farm.These samples are sent to the laboratory for determination of the biochemical and mineral composition.

1-2 Chemical analysis of feeds

The approximate composition of fish farm-made feeds was determined according to the Association of Official Analytical Chemists [11]. The moisture content of each sample was determined through a hot-air oven set at 105°C for 24 hours, and crude protein (nitrogen x 6.25) was determined using micro-Kjeldahl method. Ash was determined by incineration at 550°C in a muffle furnace for 24 h; crude fiber was quantified by acid/base digestion followed by ashing the dry residue at 550°C in muffle furnace for 4 hours and crude lipid was extracted with hexane extraction by using the Soxhlet method. The carbohydrate content was computed by taking the sum values for crude protein, lipid, ash, crude fiber and moisture and subtracting from 100. Gross energy of samples was calculated using the conversion factors of 23.7, 39.5 and 17.2 Kj for protein, lipid and carbohydrate respectively (Luquet & Moreau, 1989).The levels of calcium and phosphorus composition were obtained by microwave digestion and atomic absorption spectrophotometer from of dry samples using the techniques described by [12].

1-3 Statistical Analysis

Survey data were analyzed with the software containing Sphinx 4.5.

2-RESULTS

A total 54 fish farm-made feeds and raw materials samples were collected.

2-1-Use of fish farm-made feeds by region in Côte d'Ivoire

Production of fish farm-made is more observed in regions of south Comoe (26%), Indenie-Djuablin (13%) and Tonpki (11%) followed by Grands-Ponts (9%). The production of fish farm-made feeds by ivoirian fish farmers is very little observed in the others visited regions (Figure 1).

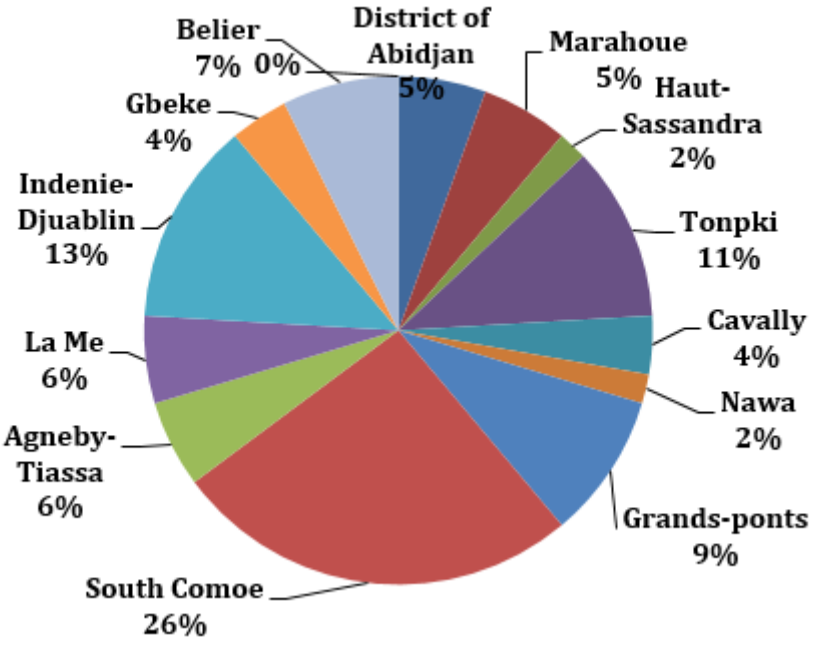


Figure 1: Use of fish farm-made feeds by region in Côte d'Ivoire

2-2- Raw materials used

Fish farmers mix their own feed by using raw materials which are usually agro-industrial byproducts. Many of these materials are cheap and available in quantity. These raw materials used to make feeds are fish meal, rice bran, bran and wheat corn, white corn bran, corn meal, coconut cake, soybean and cotton seed cake. The feed additives found in the formulation of these feeds are fish oils, soybean oil, palm oil, salt, shell, biacalcium, vitamins and minerals premix. Frequency use and inclusion rates of raw materials in fish farm-made feeds vary from one fish farmer to others.

2-2-1-Cost, frequency use, inclusion rates, availability and origin of raw materials

The cost, frequency of use, inclusion rates, availability and origin of raw materials available in Côte d'Ivoire are presented in Table 1. Fishmeal is the principal animal protein used on fish farm-made feeds. Fish meals used by fish farmers are fish carcass meal and fish bone meal (artisanal) and industrial fishmeal. These fish meals are of diverse origin, some are locally produced in the traditional way and others are produced industrially in Abidjan (REAL) or imported from Benin, Senegal, Morocco, Brazil and France. The origin and nature of fishmeal influences its price. Prices of fish meal vary between 0.50 and 1.82 $ / kg. The fish meal has an adequate availability in Côte d'Ivoire. However, it is marketed mainly in some big cities such as Abidjan, Bouake

and Yamoussoukro. The raw materials of vegetable origin (rice bran, maize, wheat, white corn bran, corn meal and coconut meal, soybean and cotton) used by fish farmers formulate their feeds have adequate availability in general. However, the white corn bran is meanly available. Wheat bran is produced industrially in Abidjan, and is imported (Morocco, Brazil, France), soybean meal is produced locally (Abidjan) and is imported from Morocco and Benin. Soybean meal is produced locally (Abidjan) and imported from Morocco, and Benin and cottonseed meal is produced in Abidjan and Bouake and also imported from Morocco. Soybean meal, cotton and coconut and wheat bran are generally sold in large cities unlike. Wheat bran, corn and rice, and corn meal are sold in almost all the localities. The average prices of raw materials sounds (rice, maize, and wheat) vary between 0.02 and 0.19 $/kg, mealy (white corn bran and corn) between 0.03 and 0.20$/kgand different cake (coconut, soya and cotton) are understood between 0.20 and 0.71$/kg.

Majority of fish farmers who mix their own feed use fish meal (77.59%), coconut meal (50%), followed by wheat bran (46.55%), white corn bran (41.40%), cottonseed meal (34.5%), corn bran (29.21%) and soybean meal (20.7%).Rice bran (18.97%) and corn meal (10.34%) are little used. Then the rates of inclusion of the raw materials, white corn bran rates (54.23%) and rice bran (53.05%) are high on average followed by corn bran (45.06%) and wheat bran (39.37%). However, coconut cake (16.50%), cotton seed cake (14.60%), corn bran (14.43%), soybean cake (10.90%) and fish meal (10.55%) are little on average incorporated in fish farm feed formulation.

Table 1: Cost, frequency use, inclusion rate, origin and availability of raw materials used to fish farm-made feeds production

Raw materials	Cost ($/kg)			Frequency of use (%)	Inclusion rate (%)			Origin	Availability
	Min	Max	Mean		Min	Max	Mean		
Fish meal	0.50	1.82	0.88	77.59	1.40	25.50	10.55	Imported and local	Adequate
Rice bran	0.02	0.15	0.04	18.97	25.00	94.30	53.05	Local	Adequate
Corn bran	0.02	0.32	0.07	29.31	6.00	86.96	45.06	Local	Adequate
Wheat bran	0.14	0.27	0.19	46.55	4.20	89.30	39.37	Imported	Adequate
White corn bran	0.03	0.13	0.05	41.40	12.60	90.90	54.23	Local	Mean
Corn meal	0.05	0.32	0.20	10.34	4.30	28.60	14.43	Local	Adequate
Coconut cake	0.09	0.27	0.20	50.00	3.30	27.80	16.50	Imported and local	Adequate
Soybean cake	0.36	0.91	0.71	20.70	1.60	47.40	10.90	Imported and local	Adequate
Cotton seed cake	0.27	0.54	0.41	34.50	4.20	33.30	14.60	Imported and local	Adequate

2-1-2-Cost, frequency use, inclusion rates, availability and origin of feeds additives

The table 2 presents a cost, frequency of use, inclusion rates, origin and availability of the feeds additives used by the fish farmers to formulate the fish feeds. The fish oil, soya oil and palm oil have adequate availability in general. They are produced in Abidjan and marketed in larges localities exception palm oil available locally. The mean cost of these oils varies between 0.80 and 3.09 $/kg. Salt, shell, the biacalcium, vitamins and minerals premix fish, poultry and pigs used have adequate availability than lysine, methionine and fish vitamin and mineral premix. Salt and shell are available locally contrary lysine, methionine premix vitamins and minerals premix imported. Some additives are marketed in Abidjan and in the larges localities. The mean cost of salt is 1.34 $/kg, shell 0.10 $/kg, biacalcium 21.82 $/kg, lysine 4.59 $/kg, methionine 8.00 $/kg, vitamins and minerals premix poultry and pigs are2.91 and 4.54 $/kg respectively. Fish oil, soya oil, palm oil, salt, shell, biacalcium, vitamin and mineral premix are little found in these feed formulas and with low incorporation rates varying on average 0.15 to 2% in fish farm-made feeds (Table 2).

2-2-Characteristic of fish farm-made feeds

The majority (94.40%) of fish farmers, who produce their feed themselves, produce him the regular occurrence. The number of raw materials used in the fish feed formulas generally varies between 3 (31.50%) and 4 (25.90%) in the majority of cases. Food formulate used fish farmers to produce fish feed is personal origin for most (40.70%). However, 22.20% of formulas are from aquaculture specialists (Technician, Researchers or Researchers-teachers). A total of 13% of these formulas comes from the extension projects of fish farming or other fish farmer, while 9.30% of formulas have been identified in scientific document extension of fish farming. Only 9.30% of fish farmers know the quality of the feed they formulate. The price of these feeds are ranging from 0.09-0.18 (25.60%) and 0.18-0.27$/kg (37.06%). Fish farmers produce feed for personal use in 98.10% of cases. The production of fish farm-made feeds is made the traditional way (98.15%) due to the lack of production unit of feed on farms visited (Table 3).Some fish farmers formulate their own fish feed from feed processing byproducts. These feeds are regularly produced in the traditional way. The feed ingredients are properly mixed together manually or by a mixing ranging in capacity from 500 to 1000 kg (Figure 2).All of fish feeds produced by fish farmers themselves are presented in meal form.

Table 2: Cost, frequency utilization, inclusion rate, origin and availability of feed additives used to fish farm-made feeds production

Rawmaterial	Cost ($/kg)			Frequency of use(%)	Inclusion rate (%)			Origin	Availability
	Min	Max	Mean		Min	Max	Mean		
Fish oil	0.82	0.82	0.82	1.70	2.00	2.00	2.00	Local	Adequate
Soya oil	3.09	3.09	3.09	3.45	0.50	0.50	0.50	Local	Adequate
Palm oil	0.91	1.82	1.26	6.90	0.02	1.20	0.59	Local	Adequate
Salt	0.91	1.45	1.34	8.60	0.10	2.00	1.00	Local	Adequate
Shell	0.05	0.18	0.10	19.00	0.30	10.40	2.89	Local	Adequate
Biacalcium	21.82	21.82	21.82	6.90	0.02	6.70	1.71	Local	Adequate
Lysine	4.00	5.18	4.59	-	-	-	-	Imported	Mean
Méthionine	8.00	8.00	8.00	-	-	-	-	Imported	Mean
Fish Vitamin/Mineral premix	6.73	6.73	6.73	6.90	0.02	0.50	0.24	Imported	Scarce
Poutry Vitamin/MineralPremix	2.91	2.91	2.91	5.17	0.03	0.40	0.15	Imported	Adequate
PigPremix Vitamin/mineral	2.54	2.54	2.54	1.72	1.00	1.00	1.00	Imported	Adequate

Table 3: Characteristic of fish farm-made feeds

Parameters	Frequency	Percentage (%)
Regular	51	94.4
Occasional	3	5.6
Total	54	100
Quantity raw materials used		
2	21	38.9
4	22	40.7
6	9	16.7
8	2	3.7
Total	54	100
Origin of food formula used		
Personal	22	40.7
Specialist	12	22.2
Project	7	13.0
Amenagist	1	1.9
Fish farmers	7	13.0
Scientifics documents	5	9.3
Total	54	100
Fish farmer analyze his feed		
Yes	5	9.3
No	49	90.7
Total	54	100
Price of fish farm-made ($/kg)		
Less than 0.09	6	11.1
0.09-0.18	16	29.6
0.09-0.27	20	37.0
0.27-0.36	9	16.7
0.36 and above	3	5.6
Total	54	100
Mode utilization of fish farm-made feed		
Personal utilization	53	98.1
Personal utilization and selling	1	1.9
Total	54	100

Figure 2: Mixer to capacity 500 kg

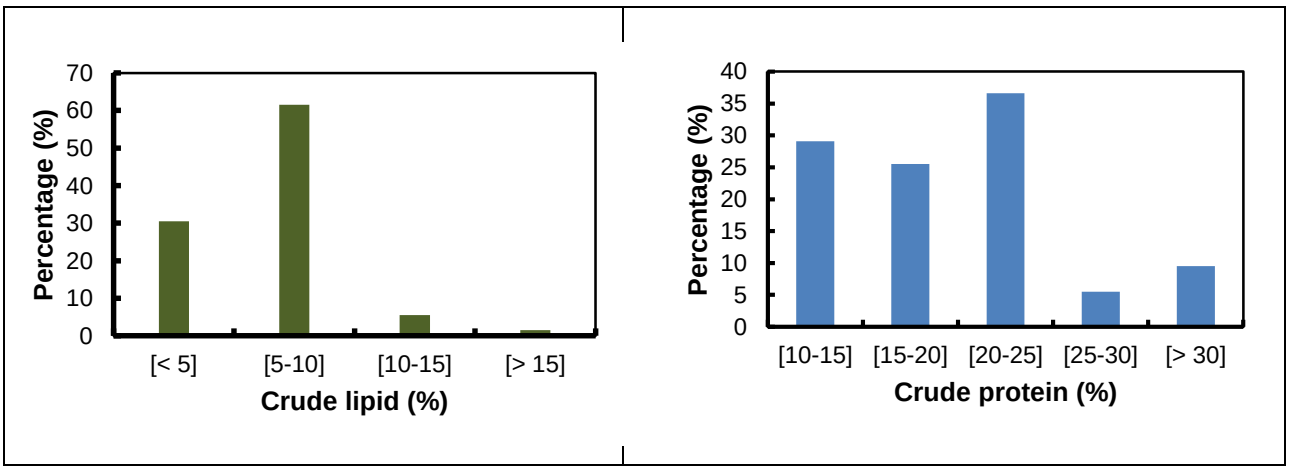
2-3-Proximate and mineral composition of fish farm-made feeds

Result of the proximate and mineral composition of the fish farmer feeds are shown in Table 4. Fish farm-made feeds contained 8.56 and 10.51% of moisture. Crude proteinvaried between 10.92 and 35.90%, crude lipid between 1.83 and 17.86%, ash between 4.70 and 16.97%. Crude fiber ranged between 4.70 and 56.33%, carbohydrates content 15.52 and 47.85%, energy between 14.44 and 21.99kJ/g. The protein/energy ratio was undertaken between 6.40 and 18,81mg/kJ, calcium between 1.22 and 13.29 mg/g, 4.37 and 65.75mg/g and the calcium/phosphor ratio of between 0.09 and 1.53. The price of fish farm-made feeds varied between 0.04 and 0.49$ with an average price of around 0.19 ± 0.09 $/kg. Table was shown the proximate and mineral profile of fish farm-made feeds produced by Ivoirian fish farmers. More than 90% of fish farm-made feeds produced by farmers are poor in protein with an understood content between 15 and 25%.The profile of the biochemical composition presented in the Table 4 permits to observe that 36.40% of fish farm-made feeds have a content proteins understood between 20 and 25%. To the total, 29.10% and 25.50% of this feed have some contents included proteins between 15 and 20% and between 10 and 15% respectively. Only 1.80% of fish farm-made feeds are rich in protein with a content superiorto 35%.However, contents in fibers of this feed are highest at the majority of Ivoirian fish feed who produced their fish feeds themselves. They vary between 10 and 25% (21.80%), 25 and 40% (36.40%) and more of 40% for 23.60%. Most this fish farmer feeds (61.80%) have a content lipids varying between 5 and 10%. In total, 56.4% of fish

feeds produced by farmers themselves have an ash content of between 5 and 10%. The contents of carbohydrates vary from less than 25% (58.20%) to between 25 and 40% to 32.70% of these feeds. Energy vary between 15 and 20 kJ/g for 94.50%, ratio protein/energy is less than 10 mg/kJ to 36.40% of fish feeds produced and included between 10 and 16 mg/kJ to 58.20%, calcium content is less than 4.50mg/g for 40% of fish farmer feeds. Most fish farmer feeds have a phosphor content between 5 and 10 mg/g (36.40%) and 10 and 15 mg/g (45.50%). The calcium/phosphor ratios are less than 0.5 (43.60%).

Table 4: Proximate,mineral compositions and price of fish farm-made feeds

Parameters	Minimum	Maximum	Mean
Mosture (%)	8.55	10.51	9.48 ± 0.55
Crud protein (%)	10.92	35.90	19.06 ± 5.33
Crud lipid (%)	1.83	17.86	6.86 ± 3.14
Ash (%)	4.70	16.97	9.15 ± 2.69
Crud fiber (%)	4.70	56.33	28.22 ± 14.60
Carbohydrate content (%)	15.52	47.85	36.37 ± 9.01
Gross energie (kJ/g)	14.44	21.99	16.66 ± 0.96
Protein/Energy (mg/kJ)	6.40	18.81	11.39 ± 2.955
Calcium (mg/g)	1.22	13.29	5.91 ± 3.26
Phosphor (mg/g)	4.37	65.75	11.90 ± 8.10
Calcium/phosphor	0.09	1.53	0.60 ± 0.35
Feed price ($/kg)	0.04	0.49	0.19 ± 0.09



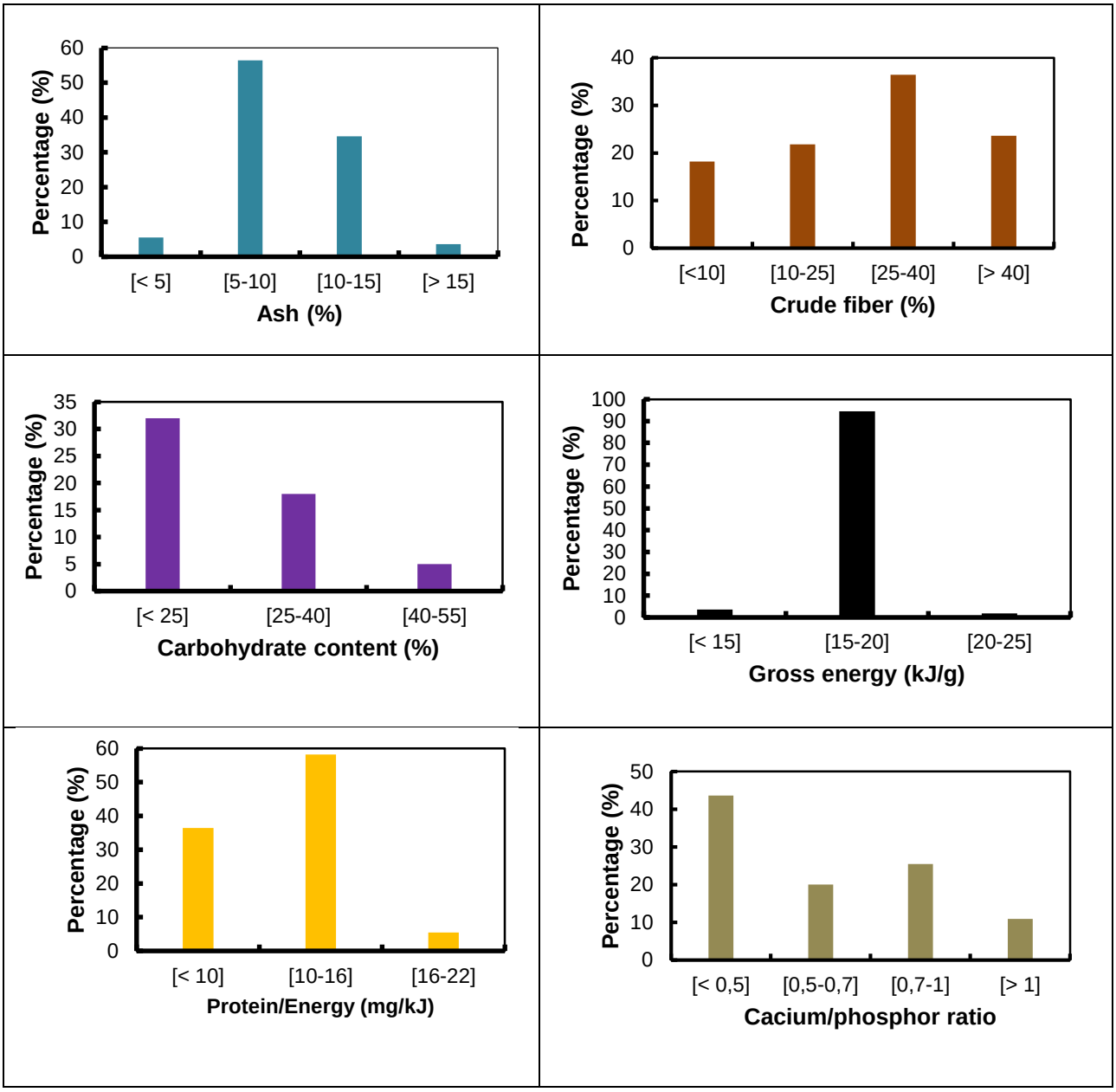


Figure3: Proximate and mineral profile of fish farm-made feeds in Côte d'Ivoire

3-DISCUSSION

The observed distribution of fish farm-made feeds according to the different regions would be due to farming systems and fish species reported by [9].The high price of commercial feed and low availability processed feeds brought the concern of some fish farmers to their products less cost of feed. However, fish farm-made feeds are always of not a good quality. Indeed, fish nutrient requirements are generally between 25-55% of protein, 4-10% of lipid, 25-40% of carbohydrate, 15-25 kJ/g of Energy, 16-22 mg/kg of protein/Energy ratio, 2-6.5 mg/g of calcium, 3-9 mg/g of phosphor, 0.7-1 calcium/phosphorus ratio, for contents of ash and 10% fiber [13-14-15]. Or, 91% of fish

farm-made feed have a protein content between 10 and 25%; 92.7% lipid content between 5-10%; 94.6% have a ratio protein/energy less than 16%; 98.1% had a carbohydrate content of less than 20%. The proximate and mineral compositions of fish farm-made feeds reported by [9] in agreement with several authors show that they have low nutritional quality. This low nutritional quality of fish farm-made could be due to the quality of the raw materials used constituted to majority of by-products. Indeed these by-products have a low content in protein with content in elevated fiber and often contain anti-nutritional substances [10-16].The raw materials used in the production of Côte d'Ivoire in fish farm-made are similar those used in Nigeria and other Sub-Saharan countries of Africa [5]. The poor quality of these fish farm-made feeds may be due to the extensive use coconut meal, rice bran, corn bran and bran wheat low nutritional value fiber rich. This high use of these raw materials could be explained by their low cost and high availability. As feed additives they are less included because of their high cost and low availability and their knowledge by fish farmer-made. The low quality of fish farm-made feed could be explained by the personal choice of food formulas. Fish fed with the produced foods have a weak zootechnic performance with a daily growth understood between 0.75 to 1.45 g/j. it could explain the low quality of the majority of feed farm-made on the fish farms of the Côte d'Ivoire revealed in this survey. Indeed, the needs in nutrients are function of the species and the stage of development and their deficit would entail a low daily growth [17]. Low quality of fish farm-made also observed in several countries in West Africa and south Asia [18-19]. It is due to the lack of production suitable feed, lack of knowledge of nutritional need of fish farming at the lack of monitoring and the absence of fish farm management specialists [18-19]. Although, the methods of feed formulation, the quality, the raw materials of fish farm-made feeds varies from one region to another, from one farmer another, however it involves combining and blending together the ingredients of animal feed into nutritionally balanced diet and witch can economically weak be used in an amount necessary to provide the desired level of production fish farming [5-20]. The processing method which includes sourcing, mixing, pelleting, drying and storing is very crucial as determines bioavailability of nutrients, feed acceptability and durability which often have profound effect on performance fish [18].So fish farm-made are less produced in Côte d'Ivoire because they are compounded and manufactured on farms and made by

small-scale producers by a traditional way or handcrafted. Promotion and improvement of fish farm-made could allow better fish production in Cote d'Ivoire.

CONCLUSION

Fish farm-made are weakly used in fish feed in Côte d'Ivoire. The raw materials used of feed formulation are available. They are mostly made from agricultural and agro-industrial by-products. However fish farm-made feeds have low quality nutritional compared to the nutritional needs of the fish farmed. Food formulas and materials used to formulate fish farm-made in Cote d'Ivoire are inadequate and lack of monitoring and supervision.

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REFERENCES

[11] AOAC. (Association of Official Analytical Chemists), 1995, Official methods of analysis, 16th edition. AOAC, Arlington, Virginia, USA, 1094p

[12] AOAC. 2003. (Association of Official Analytical Chemists), 2003, Official methods of analysis, Metals and others elements. Association of Analytical Chemist. Arlington, Virginia, USA, 1425p.

[17] Brechbühl A, 2009, The future of pisciculture in southern Côte d'Ivoire. Bachelor thesis, ETH, SC/nat CSRS, Zürish/Abidjan, 50 p.

[7] Fagbenro O.Q and Adebayo O.T, 2005, A review of the aniæal and aquafeed in Ngeria. In Asynthesis of the formulated animal and aquafeed industry in sub-sahara Africa, CIFA Occasional Paper No 26. 36p

[1] FAO, 2020, La situation mondiale des pêches et de l'aquaculture,Rome. 241p.

[18] Gabriel U.U., Akinrotimi O.A., Bekibele D.O., Onunkwo D.N. and Anyanwu P.E, 2007, Locally produced fish feed: potentials for aquaculture development in sub-Saharan Africa. *African Journal of Agricultural Research* **2 (7)**: 287-295.

[10] Guillaume J, Kaushik S, Bergot P and Metailler R, 1999, Nutrition et alimentation despoissons et crustacés, (INRA Ed.). 485 p.

[16] Francis G, Makkar HPS and Becher K, 2001, Antinutritional factors present in plant-derived alternate fish ingredients and their effects in fish, Aquaculture, 199:197-227.

[5] Hecht T, 2007, Review of feeds and fertilizers for sustainable aquaculture development in sub-Saharan Africa. Department of Ichthyology and Fisheries Science Rhodes University, Grahamstown 6140 South Africa. 34p.

[9] Koumi A.R., Kimou B.N., Atsé B.C., Ouattara I.N. andKouamé L. P, 2015, Fish Feeds Used in Côte d'Ivoire: Nature, Quality, Use and Productivity.*Asian Journal of Agriculture and Food Sciences* ***3(2)****: 225-236*

[15] Lazard J, 2007, Le tilapia. Cirad, Paris France. 5p. http://www.aquatrop.cirad.fr

[19] Mammur-Ur-Rashin M, 2013, Improving aquaculture feed in Bangladesh: from feed ingredients to farmer profit to safe cosumption. Agricultural and Biosystem. Engin. 34:1-11

[2] Muir J.F., Gitonga N., Omar I., Pouomogre V. et Radwan I, 2005, Hidden harvest unlocking the potential of aquaculture in Africa. NEPAD Fish for all Summit 22-25 Abuja Nigeria. Technical Review Paper- Aquaculture. 56p.

[13] New M.B, 1987, Feed and feeding of fish and shrimp. A manual on the preparation and presentation of compound feeds for shrimp and fish in aquaculture. ADCP/REP, 87, 26.275p.

[20] Ranjet K. et Kurup B.M, 2013, Economic analysis of polder based freshwater prawn farming systems in Kuttanad, India. *International journal of fisheries and aquaculture* **5(6)**: 110-121

[8] Toily K, 2009**,** La filière piscicole en Côte d'Ivoire : cas des régions d'Abidjan, Agboville et Aboisso. Mémoire de thèse, Ecole Inter-Etats des Sciences et Medecine Vétérinaire (EISMV) N°11. 94p.

[14] Wilson R.P et Moreau Y, 1996, Nutriment requirement of catfishes (Siluroidei).*Aquatic Living Recourses,***9**: 103-111