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Valorisation Of Certain Unconventional Foods With A View To Animal Nutrition

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Abstract – Many farmers face an animal feed shortage. The use of unconventional nutrient-rich resources is necessary. Can *Azolla*, *Musa*, *Sesamum indicum* and *Procambarus sp* fill this gap?
The weight change of the piglets fed *Azolla* is carried out. The effect of the *Musa* on the milk production of the cows is carried out. Traditionally, *Sesamum* meal, an oilseed plant, is obtained by grinding, cooking and pressing the seeds and is supposed to feed the animals. The study of *Procambarus* consists of the different drying processes: dryer, oven and in the sun.
***Azolla*, *Musa*: trunks and leaves, raw, roasted seeds and *Sesamum* cake and whole body, flesh and shells of *Procambarus* are analyzed. All samples are high in protein, *Azolla* 14% DM. *Musa*'s sheet (9.5% DM) is higher than the trunk (2.8% DM). For the meal (18% DM) of *Sesamum* is distinguished from that of the raw and roasted seeds (10% DM each). For the different drying processes of *Procambarus*, the content varies between 36.3% and 38.3% DM.**
Pigs fed or not with *Azolla* show a weight change of which those fed with *Azolla* have a high growth: Weight gain: 17.8kg against 15.0 kg. The supplement of *Musa* increases from 1 to 1.8 liters the milk production. Among the drying techniques, *Procambarus* dried in the sun (MS: 77%) is the most effective. Its by-products may be considered as animal feed. All these raw materials can well solve the animal food shortage.

Keywords – Food, Non-Conventional, Lack, Nutritional And Animal Value.

INTRODUCTION

Animal feed represents a significant fraction of the cost price of animal products. Many farmers, because of their limited resources, are struggling to produce enough feed for their animals. The use of unconventional resources begins to be prepositioned, especially in rural areas, thanks to the abundance of materials to be used, also, they are known by their potentiality and their richness in nutrients favorable to animal feed. Different types of food not in competition with human food but easily to find and inexpensive can be discerned. As a result, studies on certain unconventional foods are being considered.

Azolla of the family AZOLLACEAES, aquatic fern [4] is chosen among these foods. *Azolla* contains very large amounts of protein, amino acids, vitamins (vitamin A, vitamin B12, beta-carotene) and minerals, so it is an excellent nutritional food for livestock. *Azolla* is an ideal feed for livestock, fish, pork and poultry, and can also be used as a biofertilizer on a farm. It has a low lignin content so animals digest it easily [8]. Another diversity, banana or *Musa* sp is also adopted. The banana, family Musaceae, is native to South-East Asia. It is a perennial plant with a single stem that can be 2 to 8 m tall and is characterized by long, tender green leaves appearing successively in helical position[3], [5].

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The leaves and false trunk (trunk) of the banana tree, the fruit not marketed (sorting deviations) can be valued by the livestock. Ruminants can use all banana products, while monogastrics use only triage deviations effectively [1]. Whatever the animal species, fruit has an energy value similar to that of cereals. The sorting deviations, as well as the stipes, are however deficient in proteins. The leaves consumed by ruminants have the same nutritional value of a medium quality herb both energetically and nitrogen (protein). Leaves and trunks can be assimilated to grass that is ingested in smaller amounts due to higher concentrations of water, lignin and some other biochemical compound [9]. They can be distributed in the raw state, as harvested in the fields. However, hashing promotes the consumption of the product. Ruminants may voluntarily consume up to about 15 kg of fresh leaves and up to about 12 kg of trunk per 100 kg of live weight. Trunks are richer in water and poorer in nitrogen than leaves [1].

An assessment of oil extraction residues from sesame seeds *Sesamum indicum* is also a concept to consider. Sesame (*Sesamum indicum*) is an annual plant of the family Pédaliacée, widely cultivated for its seeds. It is the first oilseed plant to be grown. Fat-rich sesame seeds are used raw, crushed or roasted in kitchens and bakeries, or as vegetable oil for consumption without refining [2]. Sesame seeds allow the production of sesame oil which is mainly used in salads or cold dishes [7]. They represent a plant resource with a very reduced use and in addition it is a product widely expensive. They are an interesting nutritional supplement in the human diet. Apart from these uses, they are the subject of an important world culture, including Madagascar, for the production of oil. The residues from this non-exploited extraction are protein sources that can be used as animal feed.

For industries, variegated sesame seeds are used for oil extraction. Also the white seeds are extracted to have oil but used in patisseies and cosmetics. Sesame oil is the most expensive edible oil. After the extraction of the oil, the meal obtained is supposed to be used in animal feeding.

Procambarus is a genus of crayfish of the family Cambaridae, all native from North America to Central America [10]. As animal products *Procambarus sp* «Foza orana» is a crayfish intended for human consumption [6]. But only 60% are edible. The rest, such as heads, shells and tails, are either discarded, causing pollution risks to the environment or health, or incinerated and used in agriculture as composting fertilizer. Since these parts are rich in proteins, mineral fats and fats, dried and crushed, they can also be used as feed for animals such as poultry.

I- MATERIALS AND METHODS

As plant products, *Azolla*, *Musa* and *Sesamum indicum* and animal products, *Procambarus sp* are the study materials. These products are analyzed bromatologically and SPIR in the laboratory.

I-1- Experimentation with *Azolla* on piglets

Observations were made on eighteen farmers in the rural communes of Vinaninony, Miandrarivo and Faratsiho opting for the use of Azolla in the feeding of pigs. Tests on the weight of piglets are carried out. The experimental device is presented in Table 1.

Table 1: Experimental device on piglets tested with Azolla

	Control lot (4 piglets)	Lot tested (4 piglets)
Ration	Devoid of Azolla	Presence of *Azolla*

I-2- Experimentation with *Musa* on dairy cows

Also, observations on dairy cows from the Fanantenantsoa farm in the FKT of Marodinta, Urban Municipality of Antsirabe, Vakinankaratra Region tested with Musa were operated. The study was carried out on three types of farm. The animals receive 8 kg of Chloris hay and a supplement, but the presence of rice straw or Musa differs from the diet in which the quantities administered follow the experimental device shown in Table 2.

Table 2: Experimental Device on Dairy Cows with Musa

	Rice straw (Kg)	*Musa* (Kg)
Traditional farming	3,5	4,5
Midle exploration	7,8	9,5
Improved exploration	20,5	21,5

But before the distribution of banana to lactating cows, they are coarsely chopped from 6 to 8 cm. Also, bromatologic and SPIR analyses are performed on the different parts of the banana tree.

Figure 1*:* Chopped Trunks and Leaves

The milk production of each cow is measured after each milking to determine the effect of the banana tree.

I-3- *Sesamum indicum* meal production process

When making the *Sesamum indicum* artisanal cake, the seeds are crushed and then cooked for 10min. they are pressed by obtaining oil and meal (50 to 75% of the mass of the seeds). As a result, we bromatologically analyzed sesame seeds on different treatments: raw seed, roasted seed and meal. In addition, after each extraction during the determination of the Fat content, the residues still undergo the determination of the Crude Protein content called «Residual Crude Protein or PBR». This analysis step is presented in Figure 2.

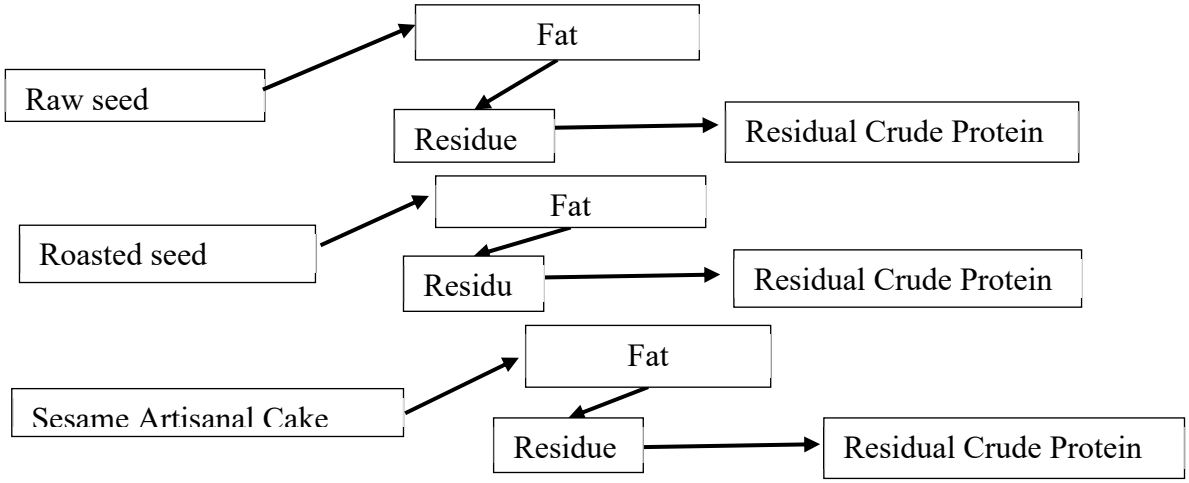


Figure 2: Analysis step for obtaining residual crude protein from Sesamum indicum seeds

I-4- *Procambarus sp* drying techniques

One of the study materials is an animal product *Procambarus sp*. Thus, the study consists on the techniques of drying these crayfish:

- Wood dryer is designed for this purpose. It is a natural dryer consisting of:

- a hot air production unit consisting of a single circulation solar collector. This sensor consists of a flat sheet metal painted in black, used as absorber and above covered with transparent plastic bag letting pass the solar radiation absorbed by the black plate. The performance of the sensor varies considerably during the day.
- a small drying chamber (height = 100cm, width = 100cm). It supports four shelves spaced of 15cm, of rectangular form in grid on which are placed the products to be dried.

Figure 3 : Wood dryer

- 103° oven for 24 hours, heated air is brought into contact with wet equipment.
- direct drying or in the open air is carried out in the sun on mats, flat rocks, or roofs of the houses and under optimal climatic conditions: a dry season with strong sunshine, low rainfall, low humidity. The drying process shows advantages such as the simplicity of the method generating a good yield.

Dehydration allows a long shelf life. The enzymes responsible for degradation are deactivated. Reduced water activity inhibits the growth of microorganisms. This system stabilizes food co-products.

The dry samples are separated into 3 parts, the meat part of which is separated from the heads, shell and tails (by-product) and part of the whole body (Figure 4). They are ground and analyzed bromatologically and in SPIR

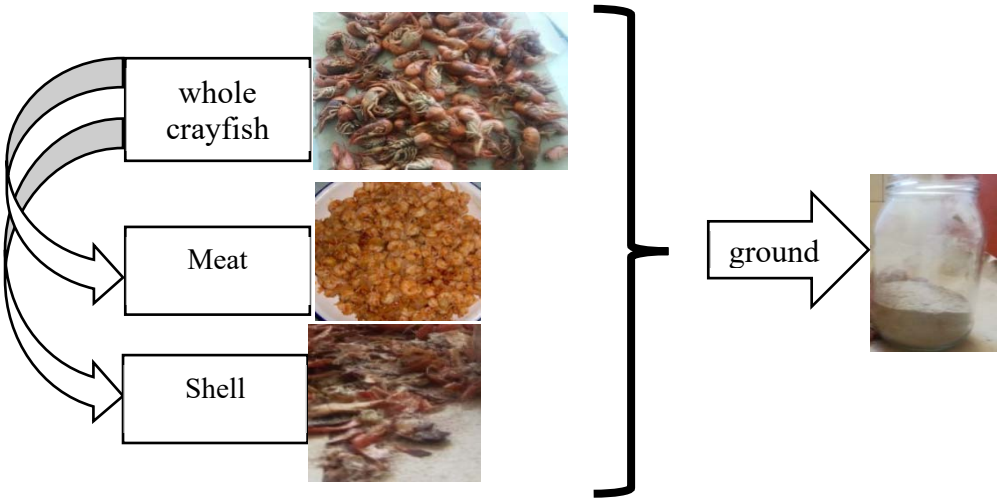


Figure 4 : Treatment of *Procambarus sp*

II – RESULTS

II-1-Azolla

II-1- 1- Nutritional value of Azolla

The nutritional value of *Azolla* is presented in Table 3.

Table 3: Chemical Composition of *Azolla*

Content in % of DM						
DM	MM	Ca	P	Fat	CP	CF
10,0	16,2	0,18	0,41	1,9	14,0	30,0

DM : Dry Matter ; MM : Mineral Materials ; Ca : Calcium ; P : Phosphorus ; CP : Crude Protein ; CF : Crude Fiber

Azolla contains a high amount of protein and mineral matter.

II-1-2- Investigation into the exploitation of peasants in Azolla

Apart from the chemical analysis, the results of the survey on the use of *Azolla* are presented in Table 4.

Table 4: Selection of farmers for employment in *Azolla*

	MIANDRARIVO	**VINANINONY**	**FARATSIHO**
E	**3**	**8**	**7**
A	100%	75%	71,42%
B	0	25%	14,29%
C	0	0	14,29%

E: number of farmers who used Azolla in the 3 sites.

A: Percentage of farmers using Azolla for pig feeding

B: Percentage of farmers using Azolla for cattle feeding

C: Percentage of farmers using Azolla for poultry feeding

Of the three sites selected, Miandrarivo uses less Azolla but all feeds it to pigs. The largest number of users is in Miandrarivo, 2/3 feed them to pigs and the rest to cattle. The average number of users is Farantsiho, of which less than 2/3 feed pigs and the rest is distributed for cattle and poultry.

II-1-3- Weight evolution of pigs fed Azolla

Following experiments on the weight of pigs fed with Azolla, the result is presented in Table 5.

Table 5: Weight change of pigs fed with Azolla

	Weeks	0	1	2	3	4
not with *Azolla*	Weight in Kg	40,5	43,5	47,0	51,0	55,5
Pigs fed of *Azolla*		41,5	45,3	49,4	54,1	59,3

Although pigs fed with *Azolla* or not have a weight change, pigs fed with *Azolla* have a higher growth.

II-2- Musa

II-2-1- Nutritional value of Musa

When studying *Musa*, its nutritional value is presented in Table 6.

Table 6: Chemical composition of the different parts of *Musa*

	DM	MM	Ca	P	CP	CF
Leaves	22,5	10,5	1,18	0,45	9,5	30,9
Trunks	9,0,	13,5	0,98	0,94	2,8	25,0
Leaves + Trunks	15,3	12,4	0,82	0,31	5,5	28,7

DM : Dry Matter ; MM : Mineral Materials ; Ca : Calcium ; P : Phosphorus ; CP : Crude Protein ; CF : Crude Fiber

According to Table 6, *Musa* has a significant nutritional value. A rich nitrogen content of the leaf relative to the trunk is observed. This superiority is explained by an increase in nitrogen content from the bottom to the top of the plant. On the other hand, the leaf and especially the banana trunk are poor in nitrogen matter. As for the mineral value, the trunk and leaf of the banana tree bring interesting qualities of Calcium.

II-2-2- Evaluation of the milk production of cows

As the nutritional value of *Musa*, the effect of its complementation on dairy production is shown in Figure 5.

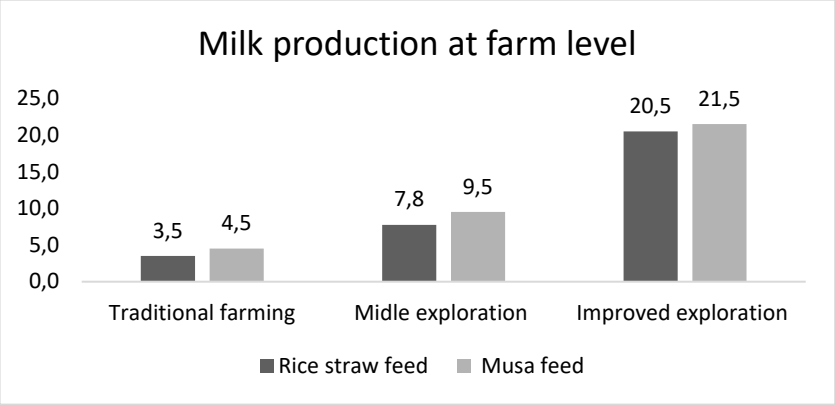


Figure 5 : Milk production at farm level

Observation at the farm level studied, as well as the information obtained during the survey, *Musa* used in feeding dairy cows increases milk production compared to the use of rice straw. It is therefore obvious that the banana tree plays an important role in milk production.

II-3- Chemical composition of *Sesamum indicum*

The results of the bromatologic analyses of *Sesamum indicum* are shown in Table 7.

Table 7: Chemical composition of *Sesamum indicum* seeds under different treatments

(% de DM)	**DM**	**MM**	**AI**	**Ca**	**P**	**CP**	**CP_R**	**Fat**
Raw **Seeds**	96,6	5,4	0,2	1,65	2,47	10,3	25,1	41,1
Roasted Seeds	99,1	5,8	0,1	1,92	2,12	10,3	23,9	50,5
Meal	93,2	6,4	0,2	4,52	1,56	18,0	25,0	39,6

DM : Dry Matter ; MM : Mineral Materials ; Ca : Calcium ; P : Phosphorus ; CP : Crude Protein ; CP_R : Crude Protein Residuale

As an oilseed plant, Fat levels are high. On the general principle of meal, the protein content is significantly higher than that of raw and roasted seeds. The levels of CP_R are higher than those of CP.

II-4- *Procambarus.sp*

II-4-1- Nutritional value of Procambarus.sp

Following the different drying techniques of *Procambarus.sp*, the results of the analysis are presented in Table 8.

Table 8: Chemical composition of *Procambarus.sp* using different techniques

Techniques	in drying			oven	In the sun
Body Part	Whole Body	Flesh	By-product	Whole Body	Whole Body
DM %	43,0	47,0	77,0	55,0	77,0
CP (%of DM)	36,3	53,2	32,3	37,6	38,3
MM (%of DM)	35,9	15,3	39,2	35,1	33,5
P (%of DM)	9,55	6,83	7,18	8,88	9,52
Ca (%of DM)	8,08	4,23	6,12	6,95	4,61
Fat (%of DM)	2,5	2,3	1,6	2,3	2,3

DM : Dry Matter ; MM : Mineral Materials ; Ca : Calcium ; P : Phosphorus ; CP : Crude Protein

The DM (77%) obtained by drying in the sun is high among the 3 drying processes. The protein content is not deteriorated. Between the DM content of the flesh part (47%) is very low against that of the by-product (77%). The protein content of the by-product (32.3%) is lower than that of the flesh (53.2%). MM content of the by-product (39.2% DM) is higher than that of the flesh (15.3% DM).

II-4-2- Advantages and weaknesses of drying Procambarus.sp

Each type of drying performed has its own advantages and weaknesses. They are presented in Table 9.

Table 9: Advantages and Weaknesses of Drying Methods

	Benefits	Weaknesses
Dryer	Less tedious Large quantities	Large areas required
Oven	Quick	More expensive
Direct	Lower investment cost	Uncertainty of time High labour costs Need for large areas Infection by insects and other foreign bodies

III- DISCUSSION

For a forage, *Azolla* has some characteristics: The intake of Crude Protein (CP) is sufficient and provides the need of the animal. Whereas the Crude Fiber (CF) content favours gastrointestinal activities. Calcium (Ca) content is an additional asset for this plant and can support pigs as needed. Nevertheless, the insufficient quantity of Fatty Matter (FM) explains the fact that this forage has a low energy potential because the feeding of pigs must have at least enough energy elements to cover its needs. These facts are illustrated in Figure 6.

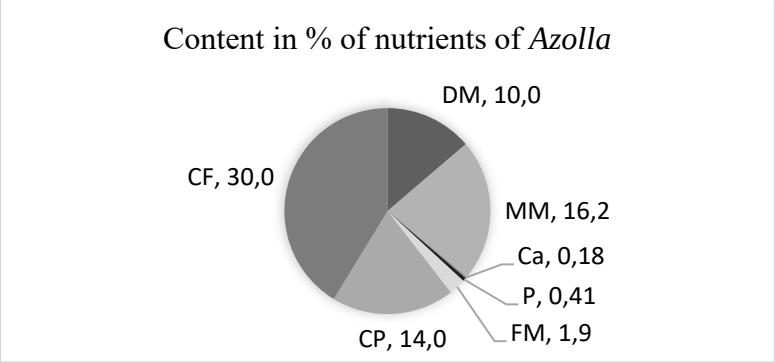


Figure 6: Essential Content of *Azolla* Nutrients

By knowing the nutrient content of *Azolla*, the weight gain of pigs resulting from the experiment is shown in Figure 7.

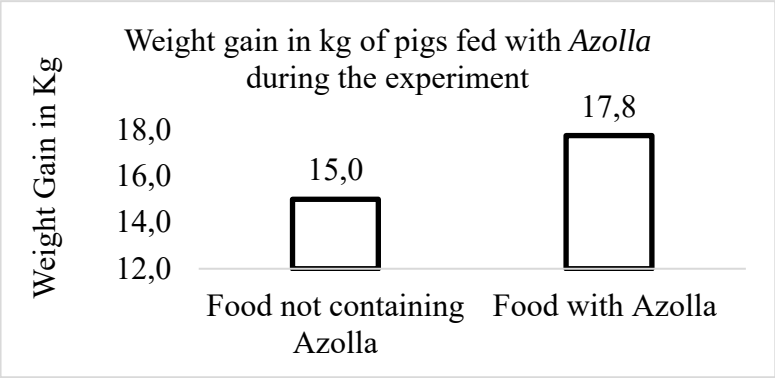


Figure 7 : Weight gain of experienced piglets by *Azolla.*

Pigs fed with *Azolla* have a higher weight gain than those without it. It is rich in protein. In rearing, it has capacity and efficiency in feeding growing pigs. It is appreciated and well digested by these animals.

Musa has a significant nutritional value. The protein content of the leaf is significantly higher than that of the trunk (9.5% versus 2.8% DM) (Figure 8)

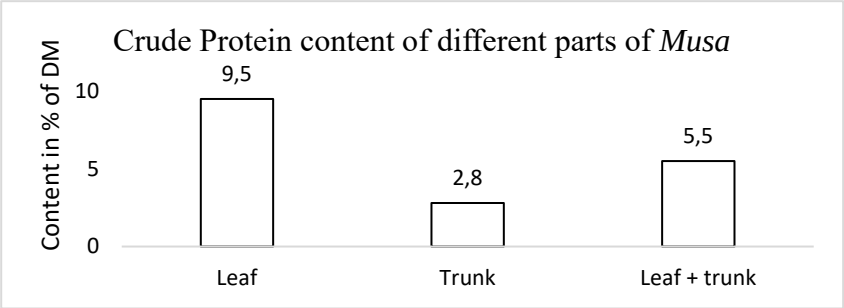


Figure 8 : Crude Protein content of different parts of *Musa*

The Ca contents of the leaf are richer than trunk but for P, this content is reversed. When the 2 parts are mixed, the Ca and P content is less than each of the 2 parts analyzed separately. (Figure 9)

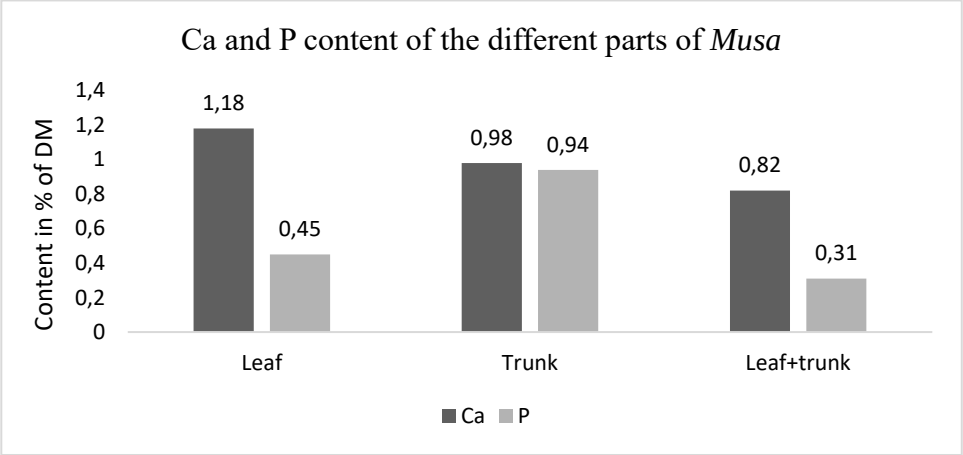


Figure 9 : Ca and P content of the different parts of *Musa*

The banana leaf is rich in terms of nutritional quality compared to the banana trunk. On the other hand, in terms of quantity, the latter is advantageous especially during the dry season because of the lack of forage in quality and quantity during this season.

Dairy production of cows increases when *Musa* is added to the diet on any farm. (Figure 10)

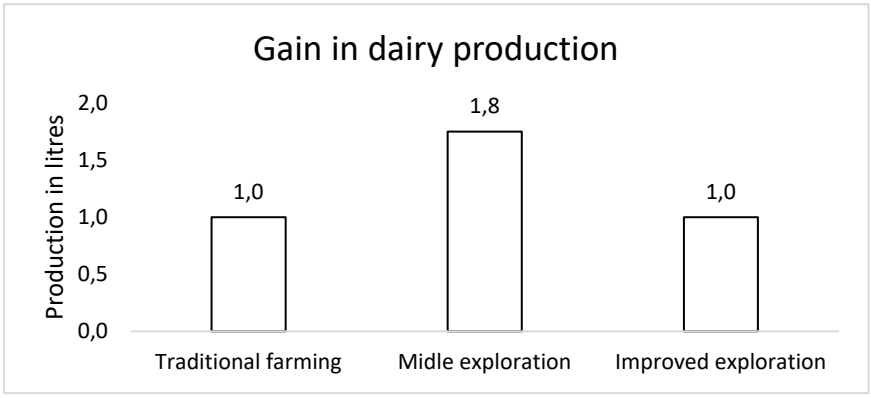


Figure 10 : Gain in dairy production by adding *Musa*

Figure 11 shows that the crude protein content of *Sesamum indicum* meal is significantly higher than the raw and cooked seed content.

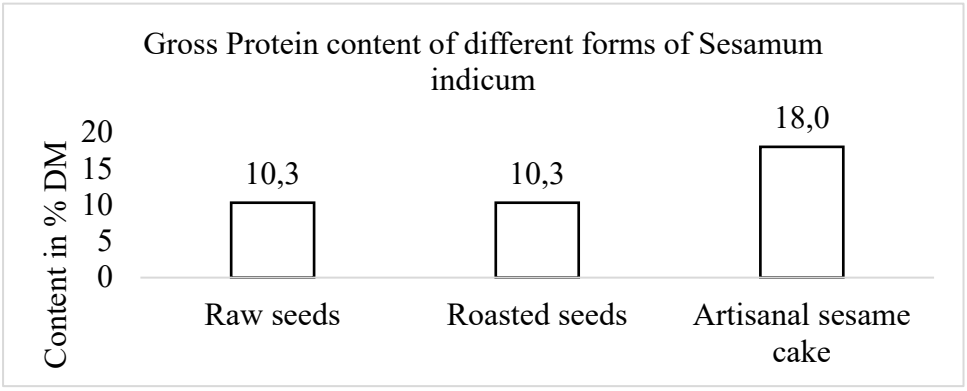


Figure 11 : Gross protein content of different forms of *Sesamum indicum*

The CP_R look like a factory extraction, the difference between the CP and CP_R is very significant. The increase in protein content from extraction is explained by the removal of oil. The comparison is shown in Figure 12.

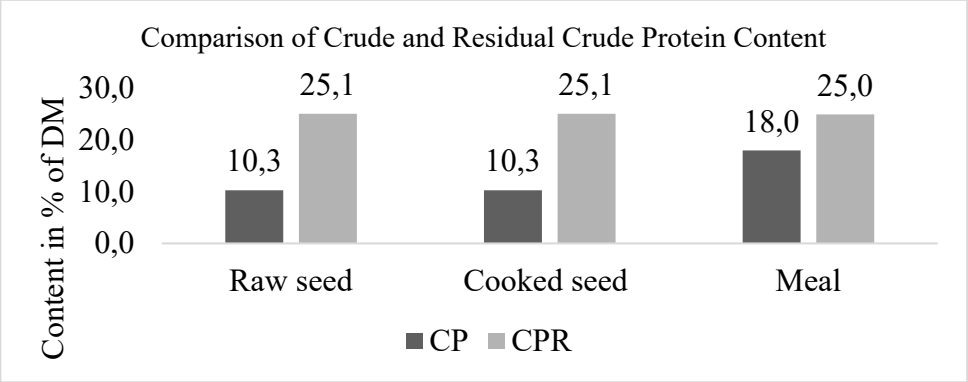


Figure 12 : Comparison of Crude and Residual Crude Protein Content of different forms of *Sesamum indicum*

Among the drying techniques, *Procambarus sp* dried in the open air (MS: 77%) is the most effective. However, this technique requires certain conditions according to the observations made such as uncertainty over time, the high labour cost, the need for large areas and the products can undergo infections by insects and other foreign bodies. The dry matter content is shown in Figure 13.

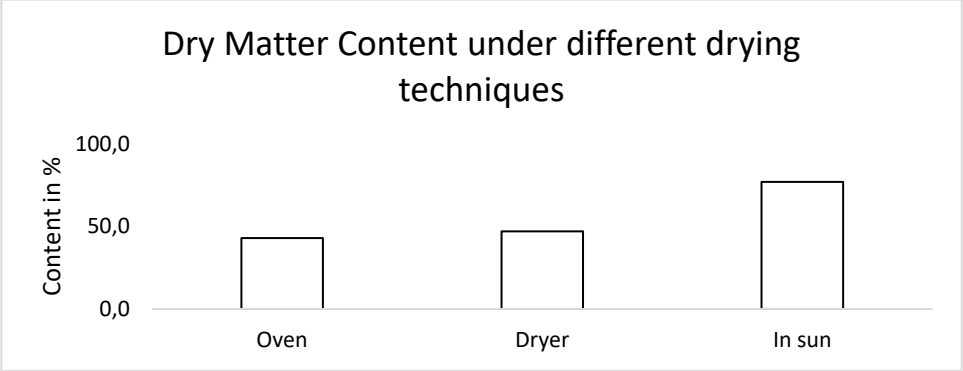


Figure 13 : Dry Matter Content of *Procambarus sp* under different drying techniques

As a result, the drying of the by-products and the flesh was carried out using the manufactured dryer. Figure 14 shows the dry matter content of these products.

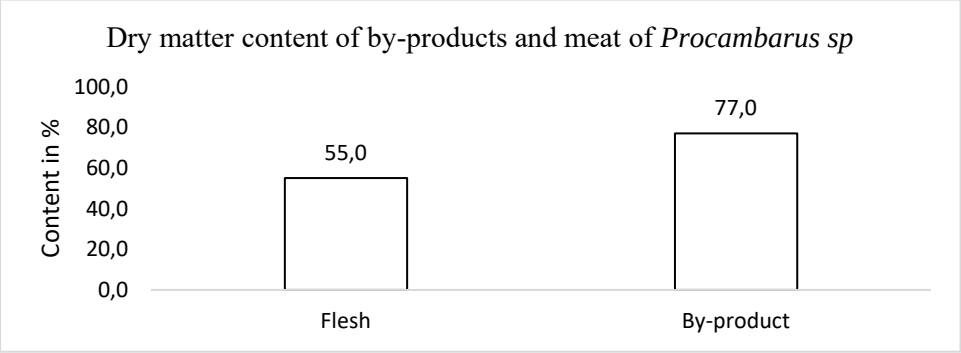


Figure 14 : Dry matter content of by-products and meat of *Procambarus sp*

Depending on the part of the body, the content of DM 77% of by-products is higher than that of the flesh of the crayfish 55%.

From the point of view of crude protein content, it is better when Procambarus sp is dried in the sun but on the drying modes, the variation of the content is minor. In addition, their crude protein content is quite high. Figure 15 shows these crude protein contents.

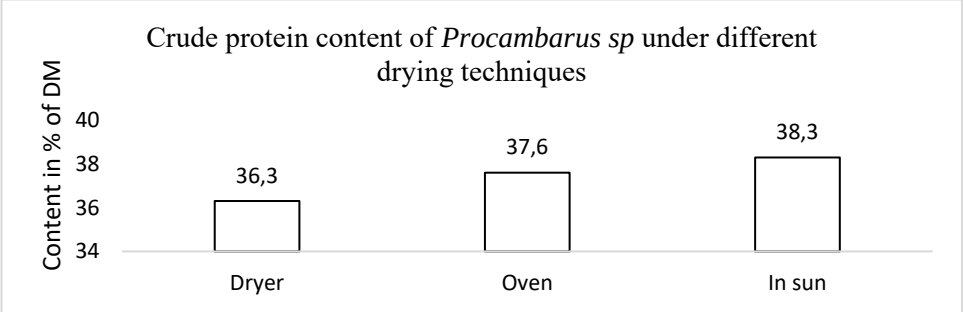


Figure 15 : Crude protein content of *Procambarus sp* under different drying techniques

The crude protein content of the flesh is much higher than that of the by-products of *Procambarus sp* but this content for the by-products may well cover the needs of the animals. The crude protein content of the flesh and by-products of *Procambarus sp* is shown in Figure 16.

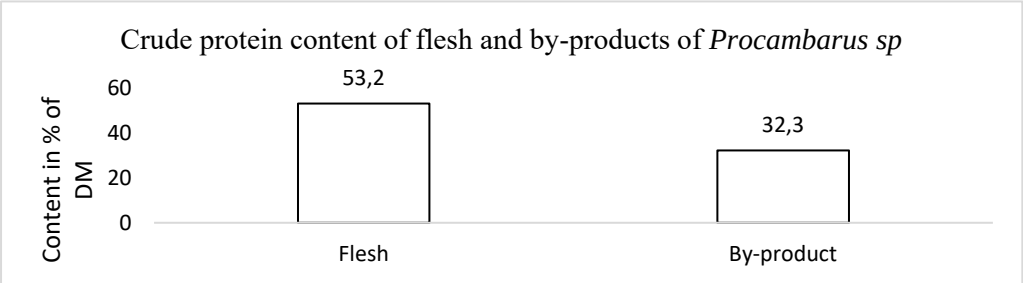
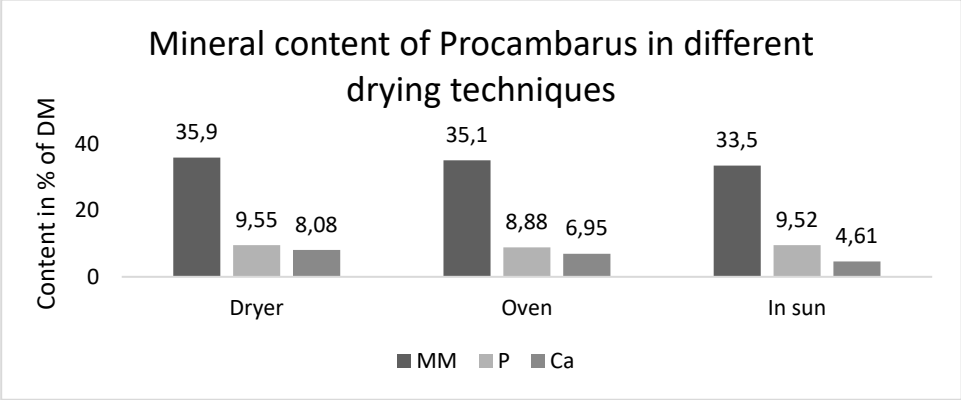


Figure 16 : Crude protein content of flesh and by-products of *Procambarus sp*

The method of drying does not cause a variation in the content of Crude Protein but the content of Phosphorus during drying in the oven and in the sun is lower compared to that of the dryer. The Ca content is almost equal for the 3 drying modes. Figure 17 shows the mineral content of *Procambarus sp* in different drying techniques.



MM : Mineral Materials ; Ca : Calcium ; P : Phosphorus

Figure 17 : Mineral content of *Procambarus* in different drying techniques

By comparing the mineral content of the flesh and by-products, the last one consisting of shells, tails and heads is rich in this nutrient especially in phosphorus. Figure 18 illustrates this content.

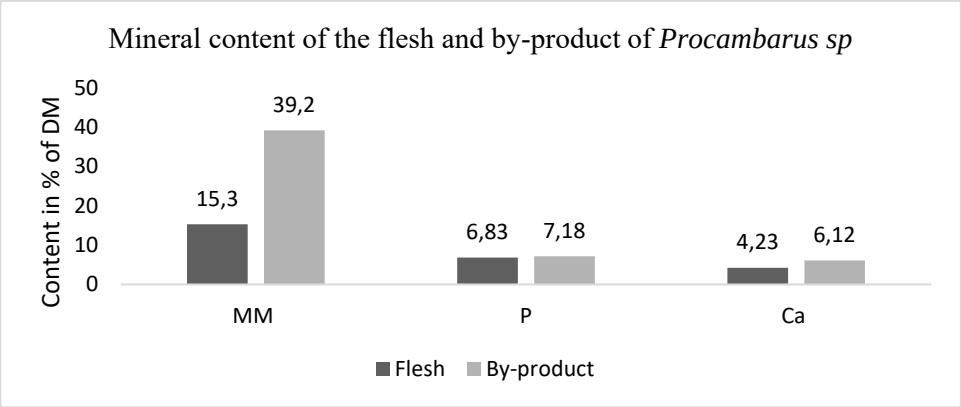


Figure 18 : Mineral content of the flesh and by-product of *Procambarus sp*

In the body part of *Procambarus*, the protein content of the flesh is high compared to the carapace in inverse to the mineral content.

IV- CONCLUSION

Banana is a very interesting potential forage resource, both qualitatively and qualitatively. It plays an important role in dairy cows' diets. It is a forage rich in calories, calcium and phosphorus. This point is of particular interest because in times of drought, the pastures are almost completely devoid of it. The use of bananas in the feeding of dairy cows contributes to the improvement of milk production and improves the profitability of the farm.

The leaf and trunk of a banana tree can be an appreciable resource of greenery for the animals that fail them in the dry season while the leaf shows an acceptable DM value. *Musa* makes it possible to facilitate the assimilation of dry foods and to maintain the water balance of the animal during the dry season.

Sesamum indicum is exceptionally rich in several nutrients. Being rich in protein, it can be well integrated into poultry and pig feed. Meal rich in fat can help the fattening of pork and in addition, rich in Calcium and Phosphorus, it can be given to laying hens. If oil extraction can be achieved by industrial extraction, the meal will be rich in protein. This study was carried out only on laboratory analysis. Animal tests prove to be necessary to exploit.

However, *Procambarus sp* must be dried before being reduced to flour for easy storage. Therefore, among the three drying methods used in the study, sun dehydration is the most effective, but time must be taken into account. For that of the oven, it is fast but expensive. The use of the dryer is not a bad concept, but the drying of many samples requires a more extensive device. In addition, as with sesame seeds, the study of crayfish also remained accurate on drying methods and chemical analyses. The deepening of the work on animal experiments will be a divergent vision of research.

In short, *Procambarus sp* are considered harmful to the environment as destruction at the rice plantation and to the decrease of production or fish yield. In addition, they have good nutritional value. Also, its meat intended for human consumption and its by-products can be used as food for animals from which there will be no competition between food and animals. So Procambarus can be helpful.

There are many techniques to achieve the drying, but the method with the help of dryer is mainly practiced and opted for thanks to its advantages. Not only is Marbled Crayfish used in poultry feed, but it can also be incorporated into swine feed due to its higher protein content.

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