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Impact of the nutritional supply of Dockounou with millet, soybean, cassava, sorghum flours in Wistar rat growth

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ABSTRACT: The purpose of this study is to enhance the senescent plantain by making dockounou with a nutritional value for feeding Wistar rat. Batches of rats were fed with dockounou boiled and formulated with millet, soybean, sorghum, cassava, maize and rice flours for 15 days. The parameters such as weight gain, dry matter intake, feed efficiency and the digestibility of various dishes of dockounou were evaluated. It appears that apart from the control diet, only the dockounou of soybean made a weight gain to 2.05 g/d and 2.25 g/d obtained respectively with the formulation 80:20 and 75:25. The high dietary intakes to 7.18 g/d and 7.51 g/d were respectively obtained at 80:20 and 75:25 formulations for the same diet. Furthermore, there is no significant difference in the food efficiency and the digestibility dockounou of soybean at both formulated and the control diet. Regarding nutritional performance of dockounou of soybean formulated to 80:20; this food could be used in the diet of Wistar rat.

KEYWORDS: senescent plantain, nutrient intake, dockounou, growth performance, digestibility.

1 INTRODUCTION

Plantains (*Musa* ssp) constitute a major source of carbohydrates for millions of people in Africa, the Caribbean, Latin America, Asia and Pacific [1], [2]. For that, they play an important role in the economy and food security of many wet tropical regions in the world [2]. It constitutes the fourth most important global food commodity after rice, wheat and maize [3] [4]. In fact, plantain is an agriculture product with carbohydrates accounting for 22% of fruit weight and rich in vitamins A, B6, C, minerals and dietary fibre [5][6]. According to [7] plantain (1,577 043 tons/year) is the third food crops in Ivory Coast after yams (3,000 000 tons/year) and cassava (1,700 000 tons/year). In spite his importance, plantain is a highly perishable fruit, which requires processing into a more stable and convenient form. Indeed, any factor can accelerate banana ripening which are the deplorable transport conditions, the absence of adequate structures of conservation and storage on the markets. This factor can also accelerate the degradation about 35 to 60% of plantains [8] [9], [10], [11].

To face the problem of short life of plantain, processing or preservation treatments are often used whose the aim is to decrease (plantain degradation) (the post-harvest losses) [12]. However studies carried by [13] showed deficiencies in the content of essential nutrients such as proteins and lipids making dockounou a food of low nutritional value. Another work according [14], at this food were improved the production parameters, the quantity of plantain senescent used, the duration of fermentation and cooking, etc. These parameters had improved organoleptic characteristics without that there is a contribution in terms of nutritional value. One solution to this problem is the preparation of dockounou to different proportions with other types of flour derived from cereal such as millet, sorghum, leguminous such as soybean, cassava root which are usually met on our markets.

The aim of this study is to valorized senescent plantain by producing nutritional feed capable to contribute at the growth of the young rats Wistar.

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2 MATERIAL AND METHODS

The senescent plantains fingers (*Musa paradisiaca*), cereals grains of maize (*Zea mays*), rice (*Oriza sativa*), millet (*Pennisetum americanum*) and sorghum (*Sorghum bicolor*), a leguminous as Soybean (*Glycine max*) and the root of cassava *(Manihot esculenta Crantz)* used in the production process were purchased from the Adjame's market (Abidjan) in Ivory Coast.

2.1 PREPARATION OF RICE, SORGHUM, MILLET AND MAIZE FLOUR

The sorghum, millet and maize flour were obtained using the method described by [15]. The rice flour was obtained using method described by [16]. The rice grains were soaked in water for two hours. After drying, the grains were crushed in a home wooden mortar, and the flour was sieved (100µm). The millet, sorghum and maize grains were cleaned and soaked in clean tap water and covered container. The soaked grains were allowed to ferment at room temperature (37°C) for 24 h. After fermentation, the water was drained and the grains rinsed with 500 mL of water and oven dried at 80°C for three hours. Then the dried grains were milled.

2.2 PREPARATION OF CASSAVA FLOUR

The method described by [17] are used for obtain flour of cassava. The roots of cassava are peeled, cut in piece then washed before being dried in the sun during 3 to 7 days. After drying, the pieces are then ground for obtaining the flour that will be sifted with sieve of 100 µms.

2.3 PREPARATION OF SOYBEAN FLOUR

The soybean flour was obtained using the method described by [18]. The soybeans grains were sorted, cleaned and blanched at 100°C for 10 min. the blanched grains were drained, dehulled and rinsed with 500 ml of water to remove the seed coat. The rinsed seed were then dried in oven at 80°C for 5 h. The dried samples of soybean were separately milled and sieved with100 µms particle size sieve.

2.4 DIET FORMULATION

The method of [13] and [14] has been used for the preparation of the various dishes of dockounou. To make themselves, the fruits of senescence plantain has been washed, peeled and crushed in a mortar made of wood for the obtaining of dough. Three (3) kinds of formulations have been achieved from the plantain dough with the different flours gotten previously. Thus, the first formulation F_1 has been done with 90% of senescent plantain dough and 10% of flour (90:10). The second formulation F_2 has been achieved with 80% of senescent plantain dough and 20% of flour (80:20) and the last formulation F_3 has been achieved with 75% senescent plantain and 25% of flour (75:25). Each sample has been fermented during 4 hours before being wrapped in the sheets of *Thaumatococcus danieilii* and cooking with water.

2.5 EXPERIMENTATION AND NUTRITIONAL PARAMETERS

The experiment was conducted with young Wistar rats from the animals' barn of the UFR Biosciences of the University of Felix Houphouet Boigny Abidjan Côte d'Ivoire. The average temperature of the room was 26°C, and the percentage of humidity was 70 %, with 12 hours of daylight and 12 hours of darkness. Nineteen groups of five Wistar rats which average initial weight varied of 50 to 75 g and to 50 ±3 day's age were used. They were divided in such a way: one group of five young rats was submitted to control diets (C. diet) which composition are reported in Table 1, six groups of five young rats were submitted to dockounou with the F_1 formulation (90:10), six others groups of five young rats were submitted to dockounou with the F_2 formulation (80:20) and the last six group of five young rats were submitted to dockounou with the F_3 formulation (75:25). The control diet used in this study is à granular which provide from the society FACI. The composition of the control diet (C. diet) is showed in table 1. Rats were disposed in individual screened bottomed cages designed separately to feed *ad libitum* for fifteen days. To be done, the method described by [18] is used and included a preliminary feeding period of ten days followed by a balance period of five days during which complete collection of faces was performed for each rat. During the period of feeding, the animals were fed between 7 a.m. and 8 a.m. every morning, and were weighed each three days. Each feed before offered was weighed, and the following day, the refused feed was also weighed, in order to determine the amount of feed intake. For the determination of the dry matter, five (5) g of every feed cooked was kept in an oven for 24

hours at 70 °C. After weighing it, the dry matter was calculated [19]. The table 2 shows the nutritional parameters which are used in this study.

Table 1. Composition of control diet (granular)

Components	Proportion
protein	15 %
Fat	3,5 %
cellulose	12 %
carbohydrate	58 %
Minerals (calcium, phosphor, etc.)	11,2 %
Vitamin A	15000 UI/Kg
Vitamin D3	3000 UI/Kg
Vitamin E	10 mg/Kg

Table 2. Expression of nutritional parameters values

Parameters	Mathematical expressions
Food intake (FI)	Food given – food refused
Dry mater (DM)	100 – [(wet weight – dry weight) / wet weight) × 100]
Dry mater intake (DMI)	FI × DM
Average weight gain (AWG)	Final weight – Initial weight
Average daily weight gain(ADWG)	AWG / 15 days
Feed efficiency (FE)	AWG / DMI
Total protein intake (TPI)	DMI × % protein of diet
Protein efficiency (PE)	AWG / TPI
Digestibility	[(protein intake – protein refused)/protein intake) × 100]

2.6 STATISTICAL ANALYSIS

The statistical analysis of data was done by one way Analysis of Variance (ANOVA) using the software IBM SPSS Statistics version 20.0. Differences between means were tested using the Duncan Multiple Range Test with 5% level of significance different figures were drawn on EXCELL 2010 Software.

3 RESULTS

The growth rates of albino rats fed with the F_1 formulation and C. diet are shown in Figure 1. The results show weight gain in albino rats fed with C. diet thereby those fed with formulated diet of D. millet; D. soybean, D. sorghum, D. cassava, D. maize, and D. rice are lower weight gain during the experiment. Moreover, rats feed with the D. soybean obtained higher weight gain than the others. For this feed, it is found a small weight loss of rats the first nine days while an increase in weight was observed the remaining days.

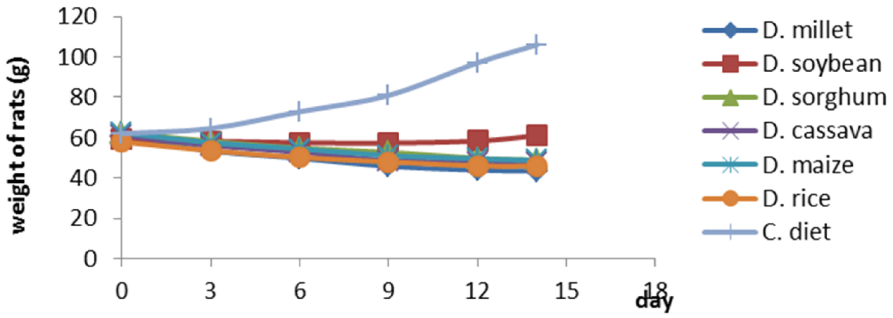

Fig. 1. Evolution of the weight of the young rats nourished with various types of dockounou in the F_1 formulation and the control diet (granular) per day

D= Dockounou, C = control

Figure 2 show the growth of rat's albino fed with the F_2 formulation and C diet. The weight of rats fed with C. diet and D. soybean is higher than those fed with D. millet, D. sorghum, D. cassava, D. maize and D. rice. In this formulation, the growth of rats fed with D. soybean and the control diet are competing. Thus, the growth of rat fed with D. soybean is higher the first nine days.

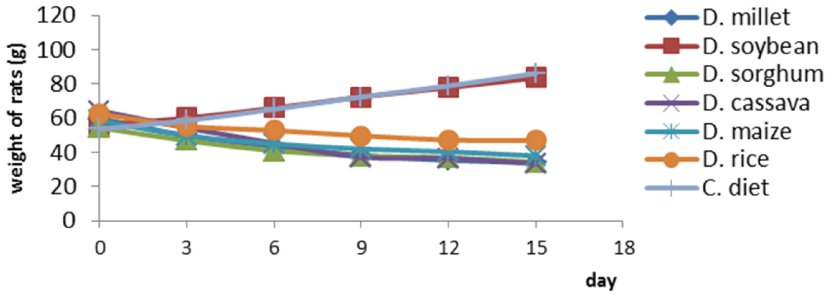

Fig. 2. Evolution of the weight of the young rats nourished with various types of dockounou in the F_2 formulation and the control diet (granular) per day

Figure 3 also show the growth of rats fed with the F_3 formulation and C. diet. The general growth of these rats is similar to the F_2 formulation with the higher growth of C. diet and D. soybean. However the weight of rat fed with dockounou of soybean is higher than those fed with C. diet the first 12^{th} days of experimentation. But, the weight of rats fed with granular catching up with weight of rats fed with dockounou soybean.

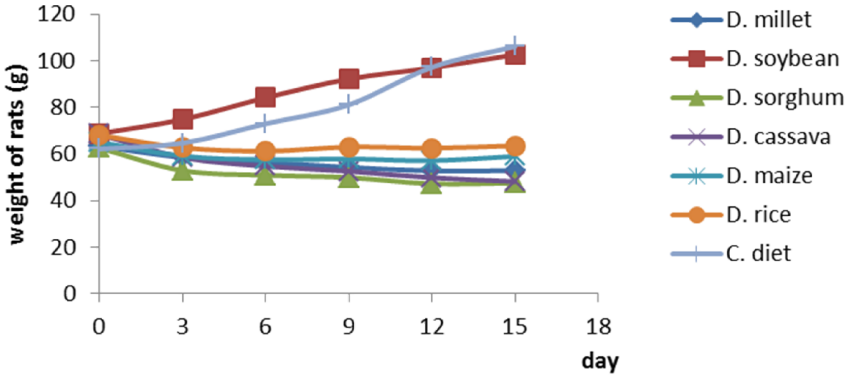

Fig. 3. Evolution of the weight of the young rats nourished with various types of dockounou in the F_3 formulation and the control diet (granular) per day

Results show that in Table 3 gain or loss weights of rats differ significantly (P > 0. 05) (Table 3). The higher of weight gain was obtained for C. diet (3.34 ± 0.27 g/d) follow by D. soybean. For D soybean, the gain of weight was respectively 0.13 ± 0.17 g/d for F_1 formulation; 2.05 ±0.84 for the F_2 formulation and 2.25 ± 0.55 for F_3 formulation. Average daily loss of weight is significantly higher for rats fed by D. millet, D. sorghum, D. cassava, D. maize and D. rice for all these formulations.

Table 3. Gain or loss of weight of rats fed with different formulations of dockounou and control diet

Type of dockounou	90:10 formulation	80:20 formulation	75:25 formulation
D. millet	-1,15 ± 0,39^{c}	-1,72 ±0,21^{de}	-0,70 ± 0,34^{cd}
D. soybean	0,13 ± 0,17^{b}	2,05 ±0,84^{b}	2,25 ± 0,55^{b}
D. sorghum	-0,90 ± 0,23^{c}	-1,34 ±0,2^{cd}	-0,99 ± 0,11^{de}
D. cassava	-0,86 ± 0,35^{c}	-2,07 ±0,32^{e}	-1,35 ± 0,12^{e}
D. maize	-0,91 ± 0,44^{c}	-1,37 ±0,12^{cd}	-0,40 ± 0,33^{c}
D. rice	-0,80 ± 0,20^{c}	-1,02 ±0,36^{c}	-0,30 ± 0,31^{c}
C. diet	3,34 ± 0,27^{a}	3,34 ± 0,27^{a}	3,34 ± 0,27^{a}

Values are mean ± standard deviation of triplicate determinations. Values with different superscripts are significantly different from each other at the 5% level (P < 0.05)

The dry matter intake of the diet is given in table 4. For the same formulations, feed consumption differ significantly (P> 0.05). The consumption was statistically higher for C. diet (11.33 ± 0.43 g/d) followed by D. soybean. For D. soybean, the consumption of fed was respectively 4.32 ± 0.67 g/d for the F_1 formulation; 7.18 ±0.79 g/d for F_2 formulation and 7.51 ±0.24 g/d for F_3 formulation. Feed consumption did not differ significantly between the types of formulation. The daily feed intake decline for D. millet, D. sorghum, D. cassava, D. maize to D. rice (5.10 ±1.27 g/d for D. rice (F_3 formulation) to 2.27 ± 0.13 g/d for dockounou of cassava (F_1 formulation)).

Table 4. Dry matter intake by rats fed with different formulations of dockounou and control diet (granular)

Type of dockounou	90:10 formulation	80:20 formulation	75:25 formulation
Dockounou of millet	3,33 ± 0,34^{c}	4,09 ± 0,26^{d}	4,52 ± 0,69^{cd}
Dockounou of soybean	4,32 ± 0,67^{b}	7,18 ± 0,79^{b}	7,51 ± 0,24^{b}
Dockounou of sorghum	2,58 ± 0,31^{d}	3,65 ± 0,41^{de}	3,89 ± 0,48^{de}
Dockounou of cassava	2,27 ± 0,13^{d}	5,02 ± 0,39^{d}	3,37 ± 0,63^{e}
Dockounou of maize	2,28 ± 0,43^{d}	3.30 ± 0,61^{e}	4,80 ± 0,75^{cd}
Dockounou of rice	2,55 ± 0,29^{d}	5,00 ± 0,55^{c}	5,10 ± 1,27^{c}
Control diet (granular)	11,33 ± 0,43^{a}	11,33 ± 0,43^{a}	11,33 ± 0,43^{a}

Values are mean ± standard deviation of triplicate determinations. Values with different superscripts are significantly different from each other at the 5% level (P < 0.05)

Table 5 shows the feed efficiency conversion of different diets established. The result indicates that feed efficiency for C. diet and D. soybean don't differed for F_2 and F_3 formulations (P> 0.05) which are best conversion efficiency.

Table 5. Feed conversion rate of different formulations of dockounou and control diet

Type of dockounou	90:10 formulation	80:20 formulation	75:25 formulation
D. millet	- 0.33 ± 0.10^{c}	-0.42 ± 0.07^{c}	- 0.15 ± 0.06^{c}
D. soybean	0.02 ± 0.03^{b}	0.25 ± 0.10^{a}	0.29 ± 0.06^{a}
D. sorghum	- 0.34 ± 0.06^{c}	-0.36 ± 0.05^{c}	- 0.26 ± 0.04^{d}
D. cassava	- 0.40 ± 0.15^{c}	-0.63 ± 0.13^{d}	- 0.40 ± 0.07^{e}
D. maize	- 0.38 ± 0.12^{c}	-0.34 ± 0.03^{c}	- 0.88 ± 0.06^{bc}
D. rice	- 0.31 ± 0.06^{c}	-0.20 ± 0.06^{b}	- 0.31 ± 0.06^{b}
C. diet	0.25 ± 0.02^{a}	0.25 ± 0.02^{a}	0.25 ± 0.02^{a}

Values are mean ± standard deviation of triplicate determinations. Values with different superscripts are significantly different from each other at the 5% level (P < 0.05)

Table 6 shows the values of digestibility of different formulations of dish and control diet. For each formulation, these values are statistical different and higher digestibilities were obtained for C. diet (88.85 ± 6.15%) and D. soybean to formulation 80:20 (84.23 ±1.47) and 75:25 (85.87 ± 1.91) respectively.

Table 6. Digestibility of different formulations of dockounou and control diet

Type of dockounou	90:10 formulation	80:20 formulation	75:25 formulation
D. millet	42.62 ± 10.34^{b}	40.06 ± 11.83^{b}	51.57 ± 16.88^{bc}
D.soybean	70.09 ± 2.78^{a}	84.23 ± 1.47^{a}	85.87 ± 1.91^{a}
D.sorghum	34.33 ± 22.85^{b}	0.16 ± 39.01^{cd}	10.22 ± 11.75^{d}
D.cassava	45.04 ± 15.50^{b}	24.5 ± 51.67^{d}	15.84 ± 40.29^{d}
D.maize	35.34 ± 26.98^{b}	24.24 ± 26.57^{bc}	70.36 ± 8.47^{ab}
D.rice	34.27 ± 13.27^{b}	35.14 ± 16.67^{bc}	44.87 ± 12.54^{c}
C. diet	88.85 ± 6.15^{a}	88.85 ± 6.15^{a}	88.85 ± 6.15^{a}

Values are mean ± standard deviation of triplicate determinations. Values with different superscripts are significantly different from each other at the 5% level ($P < 0.05$)

4 DISCUSSION

The nutrient intake of various formulations presents weight gain of rats fed with the soybean dockounou for formulation F_1, F_2 and F_3. This weight gain of rats for the three formulations shows the performance of the dockounou of soybean to develop the cellular metabolism with a synthesis of the clean matter of the rats. The weight gain of rats fed with the dockounou of soybean is in agreement with [20] (3.2 ±1.49 g/d) for the CsdN diet and superior to the study of [21] (1.05 ±0.43 g/d). This performance of the soybean dockounou could be explain by several factors such as the composition of the food and the quantity of food ingested [22], [23].Indeed the use of the soy in the manufacturing and especially the supplementation of food improve considerably the content in protein, in lipid, in vitamin and in nutriment [24], [25], [26] suggest that the indispensable nutriments to the harmonious growth of the organs are the proteins and the major minerals.

Other authors such as [27] and [28] had confirmed the interest of the proteins managed to rats owing diet are deprived (protein deprives). Regarding this fact, dockounou of soybean is important for the well life of the rats because it can assured good level of protein, lipid, vitamin and essential nutriment to their growth. The various food formulations were ingested with a significant difference. Outside of the control diet who was the more consumed with 11.33 ±0.43 g/d, the rats appetence to the D. soybean is also good (7.51 ±0.24 g/d) in relation to the rats fed with the D. millet, D. sorghum, D. cassava, D. maize and D. rice. The level of consumption for the D. soybean is comparable to the one of a régime to 10% of fish flour (7.87 g/d) [28][29][30]. This strong consumption of the D. soybean that entailed a hold of weight could explain itself according to the [31] by the taste, the texture, the flavor and the color that the flour of soybean confers to the products in which they are incorporated.

The feed conversion rate permits to appreciate the best output of use of ingested feed. The feed conversion rate of rats nourished with the C. diet and the D. soybean do not present any significant difference ($p > 5\%$).These values are respectively 0.25 and 0.29 for the control sample and the dockounou of soybean. However the D. soybean to the F_2formulation has the same feed conversion rate (0.25) that the C. diet. On the other hand the negative feed conversion rate observed with the other types of dockounou translates their inability to develop a gain of weight [32].

The study indicates that digestibility of C. diet and the D. soybean are not significant different ($p>5\%$). The values are respectively of 84.23±1,47%, 85.87±1,91% and 88.85±6,15% for D. soybean with the F_2 and F_3 formulations and for the C. diet. The digestibility of D. soybean of the F_2 and F_3 formulations are higher than those reported by [21] at the level of the RPC diet (82%). These values are also higher than those obtained [28] with the régime to basis of flour of maggots dried during 12h (74.6%). On the other hand, these results are lower to the one of [20] that got 95% of digestibility with some dishes in the Ivory Coast. This good value of digestibility of D. soybean is due to the process of preparation of the soybean flour and the fashion of cooking the dockounou [33].Indeed, according [34] and [25], the action of the heat combined to water encourage the elimination of antinutritionnal factors notably by denaturation and their diffusion in the liquid phase of the antitrypsic factors of proteinic nature. This product combines itself to the trypsin and inhibits the proteolysis. Some authors [36] are indicated that the elimination of antinutritional factors encourages the biodisponibility the proteins content in the food régime and an improvement of the proteinic digestibility.

Apart from the control diet, the set of values that translates the global conversion rate of D. soybean is higher for the F_3 formulation with feed efficiency rate 0.29 ±0.06 and protein efficiency rate 5.71 ± 1.38 that for formulation F_3 with feed efficiency rate 0.25 ±0.10 and protein efficiency rate 4.73 ±1.94. The fact that there is no significant difference between these values and the C. diet one shows that the boiled dockounou to the formulation F_2 can serve as a food of the wistar rats.

5 CONCLUSION

The soybean flour improves nutrient intake of the dockounou. The dockounou of soybean had permitted a weight gain of rats. This result suggests that the dockounou of soybean formulated with 80% of senescent plantain and 20% of soybean flour can be used as feed for wistar rats groth in laboratory in experimental goal.

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