

## Effect of Graded Levels of Spirulina (*Arthrospira Platensis*) on Feed Intake and *in vivo* Digestibility of *Trypsacum Laxum* in Guinea Pig (*Cavia Porcellus L*)

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### Abstract

The intake and *in vivo* digestibility of *Trypsacum laxum* in guinea pigs according to the graded level of spirulina was evaluated in Cameroon. 20 animals aged of 6 months with an average weight of  $450 \pm 50$  g were randomly divided into 4 equivalent groups. Each group received *T. laxum* and 40g of compound feed containing 0% (TS0), 2% (TS2), 4% (TS4), and 6% (TS6) of spirulina. Feed intake was the different between the left over and the quantity served. The sample of *T. laxum* and those of each diet as well as feces were collected and analyzed for the apparent digestibility of each nutrient. Animals were weighed at the beginning and at the end of each period of the test to determine the body weight gain. This study showed that the average daily intake of dry matter (DM) for TS0, TS2, TS4 and TS6 was  $74.39 \pm 2.98$ ,  $78.66 \pm 3.14$ ,  $83.89 \pm 4.28$  and  $77.76 \pm 4.40$  g/head/day. The highest apparent digestibility coefficients of different nutrients were obtained with animals fed TS6 group while the lowest were observed in TS0. The apparent digestibility coefficient of dry matter (DM), organic matter (OM) and crude protein (CP) of the supplemented group were statistically higher than those of the control diet. Animals' weight performances were statistically comparable between treatments. Thus, the combination of *T. laxum* with concentrated feed containing spirulina can be recommended for guinea-pigs, but the level of incorporation may not exceed 4% of its daily ration.

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## Introduction

Food insecurity in general and protein shortage in particular is a real problem in African countries [1]. The deficit in animals protein due to the increasing population have led to the search for other sources of readily available and more affordable protein sources of animal origin [2]. Guinea pig is favored as alternative [1, 3], because of its high growth rate, low fat and protein-rich meat that constitutes a major advantage of production [4, 5]. In addition, it is a secondary source of income. In fact, breeding is an important asset [6] that can address several food and socio-economic issues in low-income families [7]. Despite these advantages of guinea pigs, in Cameroon, its production remains weak because of several constraints including food management. The animals are fed on kitchen waste and crop residues. This situation does not allow this monogastric herbivore to satisfy the needs of its caecal flora and externalize its genetic potential [8]. Improvement in guinea pig productivity can be achieved through a balanced diet [9, 10], with dietary protein being the most important component of production cost and at the same time the limiting factor. The high cost of concentrates commonly used as protein supplement in guinea pigs, [11-13] leads to higher cost of production and does not always make it possible to obtain a good productivity [7]. The search for other sources of supplements available and assimilable by the animal, including green supplements [13] is more necessary, to optimize the use of *T. laxum* and keep animals in acceptable performance [12]. However, many legumes can be used, but generally adapted to rodents, due to concentration of anti-nutritional factors in the plants [14]. Spirulina because of its high protein content (60 to 75%) and its high digestibility (75 to 80%) could be a protein source to improve productivity and reduce the cost of production. Unfortunately, very little research on spirulina has been initiated or published on the rationalization of food use in cavies. It is in this perspective that this study was undertaken to evaluate the effect of four levels of supplementation with spirulina on the *in vivo* digestibility of *T. laxum*.

## Material and Methods

### *Area of Study*

The study was conducted over a period of 15 days (from January 10 to 25, 2018) at the teaching and Research Farm of the University of Dschang, located in the Highlands of the West region of Cameroon at an altitude of 1410 m above sea level between latitude 5° 26' and longitude 10°26'. The annual rainfall is between 1500 and 2000 mm/year, with temperatures ranging from 10 ° C to 25 ° C. The climate is a Cameroonian equatorial climate temperate by the altitude, with the dry season from mid-november to mid-march and rainy season from mid-march to mid-november.

### *Animal and Housing*

Twenty guinea pigs (*Cavia porcellus*), born at the Teaching and Research Farm (FAR) of the University of Dschang were used in this study. They were about 5 months old with an average weight of 450 ± 50 g. The animals were housed in single wired metabolic cages each measuring 80 cm x 50 cm x 30 cm and lined with mosquito nets, which were used to collect feces. Each cage was equipped with a feeder, a trough and a lighting device.

### *Experimental Feeds*

The basal diet was *T. laxum* harvested at the FAR and distributed to animals after preweaving for two hours on sun. Spirulina was used as a supplement and was purchased in markets around Lake Tchad. It was dried, crushed and incorporated at different levels to form the experimental rations. A 100 g sample of each feed, forage and spirulina was taken and dried at 60 ° C to constant weight in a Gallemkamp brand ventilated oven. Then, it was milled into powder of sieve size 1 mm using a home-made trimarteau shredder of small size and kept in plastic bags for different bromatological analysis. The chemical composition as analyze in the laboratory of *T. laxum*, spirulina and the sample feed is presented in Table 1 and 2. Four rations were formulated (Table 2) according to the level of inclusion of spirulina. Apart from spirulina, all the ingredients used in the ration formulation were purchased from agricultural by-product dealers at the Dschang city market. The control diet did not contain spirulina while R1, R2 and R3 contained 2%, 4% and 6% Spirulina. All

Table 1. Chemical composition of *Trypsacum laxum* and spirulina (*Arthrospira platensis*)

	DM (%)	OM (% DM)	CP (% DM)	CF (% DM)	Ashes (% DM)
<i>T. laxum</i>	94.28	84.63	13.26	37.77	08.17
Spirulina	94.60	89.27	61.3	16.5	08.6

DM: dry matter, OM: organic matter; CP: crude protein, CF: crude fiber

Table 2. Composition of formulated concentrate feeds with graded levels of spirulina

Ingredients	R0	R1	R2	R3
Corn	26	26	28	37
Wheat bran	48	48	45.5	36
Soybeanseed cake	6	4	2	0
Cottonseed cake	3	3	2.5	1.5
Palm kernel cake	7	7	8	8
Fish meal	6	6	5	6
Bonemeal	2	2	2	2
Cooking salt	1	1	1	1
Premix (2%)	1	1	1	1
Spirulina	0	2	4	6
Palm oil	0	0	1	1.5
Total	100	100	100	100
Chemical Composition (% DM)				
DM	93.97	94.12	94.47	94.90
OM	88.83	89.81	86.29	88.78
CP	19.30	19.46	19.10	19.20
CF	9.00	8.96	8.65	7.95
Ash	09.17	08.21	11.82	09.32
Metabolisableenergy	2870	2820	2804	2812
Lysine	1.02	1.02	0.94	0.9
Methionine	0.46	0.46	0.47	0.46

these rations were iso-nitrogenous (19% PB) and iso-caloric (2800 Kcal). To deal with a possible deficiency, vitamin C, (240 mg tablet in 1.5 liters of water) bought from a pharmacy was distributed to all animals daily in drinking water served *ad libitum*.

*Different Treatments were Prepared as Follow:*

TS0: 40g/head/day of R0+*Trypsacum laxum ad libitum* (n = 5)

TS2: 40g / head /day of R1+*Trypsacum laxum ad libitum* (n = 5)

TS4: 40g / head /day of R2+*Trypsacum laxum ad libitum* (n = 5)

TS6: 40g / head /day of R3+*Trypsacum laxum ad libitum* (n = 5)

*Experimental Design*

The guinea pigs were randomly distributed into labeled individual cages, and assigned to the 4 treatment diets in a completely randomized design with 5 replicates. The days trial lasted for 15 days (10 days for adaptation and 5 days for data collection). Each ration was served between 8 and 9 o'clock every day and left over feed, and the feces of each animal were collected and weighed daily before daily feeding and watering, for the assessment of feed intake. At the beginning of the test and at the end of each period, the animals were weighed to determine daily weight gain.

During the test, samples of 100 g of experimental feed and feces from each animal were taken daily and dried at 60 ° C to constant weight in a ventilated oven and milled to determine the digestibility of nutrients. At the end of the test, animals were fasted for 12 hours, and then sacrificed by cervical dislocation followed by bleeding. They were then dressed at the abdominal area and then eviscerated. The caecum was removed, sectioned, and their content was put into sterile tube to evaluate the caecal flora constitution according to the method described by Benson [15]. Weighing was made using a digital scale balance with a capacity of 3 kg and a precision of 1 g. At the end of the study, mean values of feed intake, average daily gain, and apparent digestibility coefficients of nutrients were determined.

*Chemical Analysis of Feed and Faces*

The dry matter (DM) and organic matter was determined by drying 0.5 g of sample in an oven overnight at 100 ° C, ash was obtained by incineration at 500 ° C for 6 hours and organic matter (AOAC, 1990). Crude fiber (CF) was determined using the sheerer method and crude protein (CP) by the Kjeldahl method by AOAC [16]. Apparent digestibility coefficients (ADC) were determined by the following formula:

$$ADC = \frac{\text{Ingested} - \text{excreted}}{\text{ingested}} \times 100$$

*Statistical Analyses*

Feed intake, apparent digestibility coefficients and caecal flora constitution data were subjected to one-way analysis of variance. When significant differences existed between treatments, the separation of means was done by the Duncan test at 5% significance level [17]. SPSS 20.0 software was used.

## Results

*Feed Intake By Guinea Pigs*

Table 3 shows the dietary intake of guinea pigs during *in vivo* digestibility test This table shows that spirulina level significantly (p < 0.05) influenced intake of *T. laxum*, and nutrients (DM, OM, CF and CP). The highest quantity of *T. laxum* DM ingested (63.22 g DM/head/day) was observed with animal fed on TS4 while the lowest (53.74 g DM /head/ day) was recorded with animals fed TS0 diet. However, ingestion of *T. laxum* DM by animal fed TS2 and TS6 groups was comparable (p > 0.05). For the ingestion of *T. laxum* OM, the highest (56.75g DM /head/ day), was observed in animals fed with TS4 while the lowest (48.59 g DM /head/ day) was observed in animals fed TS0 but no significant difference (p > 0.05). However, feed intake of *T. laxum* OM of the animals of TS2 and TS6 groups was comparable (p > 0.05), but significantly (p < 0.05) higher than that of TS0 group. The highest compound feed OM feed intake (19.03 g DM /head/day) was obtained with TS0 lot animals while the lowest (17.82 g DM /head/ day) was obtained with the animals of group TS2. The highest *T. laxum* CF intake (25.33 g DM /head/day) was obtained with TS4 animals fed on treatment TS4 while the lowest (21.69 g DM /head/ day) was observed with animals of group TS0. However, *T. laxum* CF intake was comparable (p > 0.05) between the animals of groups

Table 3. Effect of graded levels spirulina on cavy feed intake

intake (g DM/head/day)	Treatments				SEM	p
	TS0	TS2	TS4	TS6		
Dry matter						
<i>T. laxum</i>	53.74 <sup>a</sup>	59.99 <sup>bc</sup>	63.22 <sup>c</sup>	57.54 <sup>ab</sup>	1.96	0,00
Compound feed	20.65 <sup>a</sup>	18.67 <sup>a</sup>	20.67 <sup>a</sup>	20.21 <sup>a</sup>	1.16	0,31
Total DM	74.39 <sup>a</sup>	78.66 <sup>a</sup>	83.89 <sup>b</sup>	77.76 <sup>a</sup>	2.38	0,00
Organic matter						
<i>T. laxum</i>	48.59 <sup>a</sup>	53.96 <sup>bc</sup>	56.75 <sup>c</sup>	51.80 <sup>ab</sup>	1,77	0,00
Compound feed	19.03 <sup>a</sup>	17.82 <sup>a</sup>	18.88 <sup>a</sup>	18.91 <sup>a</sup>	1,08	0,66
ein	67.62 <sup>a</sup>	71.77 <sup>ab</sup>	75.63 <sup>b</sup>	70.71 <sup>ab</sup>	2,22	0,01
Crude Prot						
<i>T. laxum</i>	7.61 <sup>a</sup>	12.38 <sup>c</sup>	8.89 <sup>b</sup>	8.09 <sup>a</sup>	0.32	0,00
Compound feed	4.24 <sup>bc</sup>	3.86 <sup>b</sup>	2.01 <sup>a</sup>	4.30 <sup>c</sup>	0.18	0,00
Total CP	11.85 <sup>b</sup>	16.24 <sup>c</sup>	10.90 <sup>a</sup>	12.84 <sup>b</sup>	0.34	0,00
Crude Fiber						
<i>T. laxum</i>	21.69 <sup>a</sup>	24.02 <sup>bc</sup>	25.33 <sup>c</sup>	23.04 <sup>ab</sup>	0.77	0,00
Compounded feed	1.99 <sup>a</sup>	1.78 <sup>a</sup>	1.85 <sup>a</sup>	1.70 <sup>a</sup>	0.12	0,14
Total CF	23.67 <sup>a</sup>	25.80 <sup>bc</sup>	27.18 <sup>c</sup>	24.74 <sup>ab</sup>	0.79	0,00

<sup>a, b, c</sup>: Mean bearing the same letter on the same line are not significantly different at 5%; SEM : standard error of mean; p : Probability ; TS0, TS2, TS4, TS6 : *Trypsacum laxum*+ compound feed with 0, 2, 4 et 6% of spirulina

Table 4. Effect of graded levels of spirulina diets on apparent digestive utilization coefficients (ADC) of nutrients in guinea pigs

Nutritient	Treatments				SEM	P
	TS0	TS2	TS4	TS6		
Dry Matter	75.67 <sup>a</sup>	79.92 <sup>ab</sup>	83.20 <sup>bc</sup>	86.20 <sup>c</sup>	1.82	0,01
Organic Matter	75.12 <sup>a</sup>	80.31 <sup>a</sup>	81.50 <sup>ab</sup>	87.30 <sup>b</sup>	3.04	0,01
Crude Fibre	88.06 <sup>a</sup>	92.35 <sup>b</sup>	89.46 <sup>ab</sup>	93.73 <sup>b</sup>	1.84	0,04
Crude Protein	78.05 <sup>a</sup>	81.21 <sup>ab</sup>	83.93 <sup>bc</sup>	87.54 <sup>c</sup>	2.61	0,01

<sup>a, b, c</sup>: Mean bearing the same letter on the same line are not significantly different at 5% significant level: SEM : standard error mean; p : Probability ; TS0, TS2, TS4, TS6 : *Trypsacum laxum*+ compound feed with 0, 2, 4 et 6% of spirulina.

TS0 and TS6 on one hand and those of treatment TS2 and TS4 on the other hand. The highest compound feed CF intake (1.99 g DM/head/day) was observed in TS0 animals while the lowest (1.70 g DM /head/day) was observed with animals of group TS6. The highest *T. laxum* CP intake (16.24 g DM/head/day) was observed with TS2 animals while the lowest (10.90 g DM/head/day) was observed with animals of group TS4. However, animals of TS0 and TS6 groups had similar CP intake ( $p > 0.05$ ). The highest compound feed CP feed intake (4.30 g DM/head/day) was observed with animals fed TS6 while the lowest (2.01 g DM/head/day) was observed in animals of group TS4. In addition, the CP intake of the compound feed of treatment TS0 and TS2 was comparable ( $p > 0.05$ ). Although, DM, OM and CP intake of the compound feed of animal of groups TS0, TS2, TS4 and TS6 were comparable ( $p > 0.05$ ).

On average, intake of DM, OM and CF significantly ( $p < 0.05$ ) increased with the level of spirulina in the diet. In fact, the total highest DM (83.89 g / animal/ day) was observed with animals of group TS4, while the lowest (74.39 g DM/head/day) was observed with animals of group TS0. However, the total DM intake of the animals of groups TS2 and TS6 was comparable ( $p > 0.05$ ), but significantly lower than that of group TS4. The highest total OM (75.63 g DM/head/day) was observed with animals of group TS4 while the lowest (67.62 g DM /head/ day) was observed with TS0 animals. However, OM intake of the animals from TS0, TS2 and TS4 was comparable ( $p > 0.05$ ). The total highest CF intake (27.18 g DM/head/day) was observed with TS4 animals while the lowest (23.67 g DM/head/day) was observed in animals of group TS0, but it was comparable ( $p > 0.05$ ) with the animals of TS0 and TS6 groups. The total CF intake of TS2 animal group was significantly higher than those of animal of group TS6. Total highest CP intake (16.24 g DM/head/day) was observed in TS2 animals, while the lowest (10.90 g DM/head/day) was observed with animals fed TS4 group. Intake of animals of TS2 group was significantly ( $p < 0.05$ ) higher than those of the other groups. Total CP intake of animals fed TS0 and TS6 diets were comparable.

#### *Apparent Digestibility Coefficients (ADC) of Nutrients in Guinea Pigs*

The apparent digestibility coefficients (ADC) of dry matter (ADCDM), organic matter (ADCOM), crude protein (ADCCP) and crude fiber (ADCCF) with respect to the level of incorporation of spirulina in the diet was significantly ( $p < 0.05$ ) improved. (Table 4) In fact, the highest apparent digestibility coefficients of dry matter (ADCDM) (86.20%), organic matter (ADCOM) (87.30%), crude cellulose (ADCCF) (87, 54%) and crude protein (ADCCP) (93.73%) were obtained in TS6 animals, while the lowest (75, 67%, 75, 62%, 88, 06% and 78, 05% respectively were observed in the control group (TS0). However, the ADCDM, ADCOM and ADCCF of TS0 and TS2 groups on one hand, and the TS4 and TS6 groups on the other hand were comparable. The ADCCP of the treated groups (TS2, TS4 and TS6) were comparable ( $p > 0.05$ ), but significantly ( $p < 0.05$ ) higher than that of TS0 group. Also, ADCCP of groups TS2 and TS4 were comparable ( $p > 0.05$ ).

#### *Animal Weight Performance*

Total weight gain and daily weight gains during digestibility were comparable between treatments. Mean total weight gain and mean total daily weight gain were highest in TS4 group animals, while the lowest was record with TS6 animals (Figure 1).

#### *Constitution of Guinea Pig Ceecal Flora.*

The effect of spirulina level on the composition of the guinea-pig flora is illustrated by the table 5.

This table shows that, the highest level of lactobacilli (8.09 CFU/ml) was obtained with TS2 group while the lowest (8.03) was obtained in animals of group TS6. The highest rate of enterobacilli (5.06) was obtained at 4% supplementation of spirulina while the lowest (4.95) was obtained at 6% inclusion level. The highest level of Salmonella (4.47) was observed with 6% spirulina inclusion level while the lowest (4.40) was observed when the animal was fed with 2% (TS2) spirulina. However, no significant difference ( $p > 0.05$ ) was observed for the different treatments.

Regardless of the treatment, but ceecal floral within treatment (Figure 2), lactobacilli level was significantly ( $p < 0.05$ ) higher than enterobacilli and salmonella (Figure 2). The rate of lactobacilli, enterobacilli and salmonella of supplemented group are comparable with those of the control group.

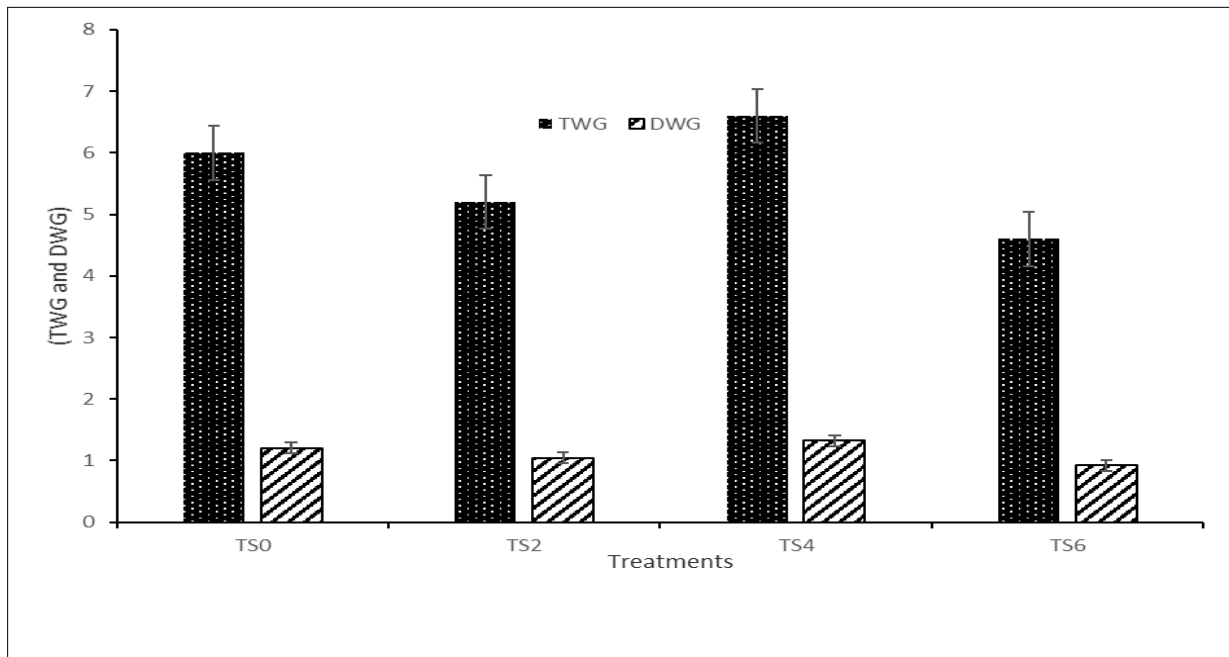


Figure 1. Total weight gain (TWG) and Daily weight gain (DWG) of different levels of spirulina during the period of in vivo digestibility

a, b, c: Mean bearing the same letters on the same line are not significantly different at the 5% level; SEM: standard error of mean; p: Probability; TS0, TS2, TS4, TS6: *Trypsacum laxum*+ Compound feed containing 0, 2, 4 and 6% of spirulina.

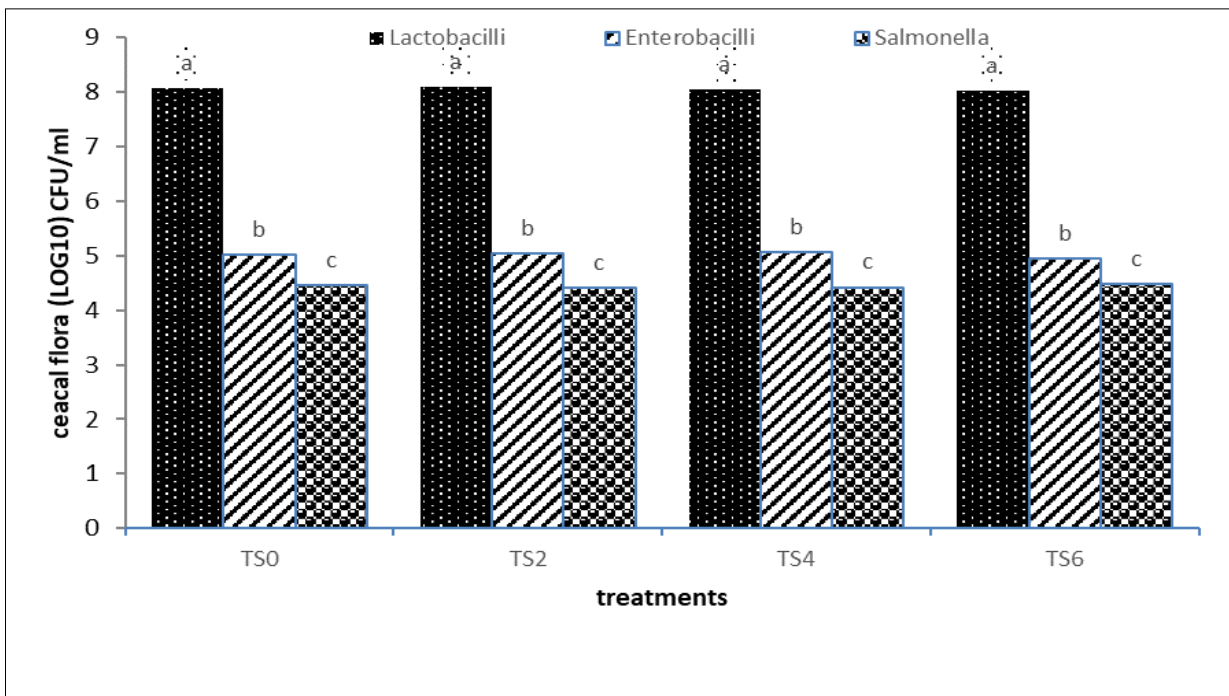


Figure 2. Comparative rate of Lactobacilli, Enterobacilli and Salmonella with different levels of spirulina

a, b, c: mean with the same letters on the same are not significantly different at the 5% level; p: Probability; TS0, TS2, TS4, TS6: *Trypsacum laxum*+ Compound feed containing 0, 2, 4 and 6% of spirulina.

Table 5. Effect of spirulina level on guinea pigs caecal flora.

Caecal Flora (CFU/ml Log <sub>10</sub> )	Treatments				P
	TS0	TS2	TS4	TS6	
<i>Lactobacilli</i>	8.07 ± 0.12 <sup>a</sup>	8.09 ± 0.20 <sup>a</sup>	8.05 ± 0.08 <sup>a</sup>	8.03 ± 0.14 <sup>a</sup>	0,94
<i>Enterobacilli</i>	5.01 ± 0.15 <sup>a</sup>	5.04 ± 0.07 <sup>a</sup>	5.06 ± 0.10 <sup>a</sup>	4.95 ± 0.09 <sup>a</sup>	0,62
<i>Salmonella</i>	4.46 ± 0.15 <sup>a</sup>	4.40 ± 0.17 <sup>a</sup>	4.42 ± 0.22 <sup>a</sup>	4.47 ± 0.18 <sup>a</sup>	0,95

<sup>a, b, c</sup>: Mean bearing the same letter on the same line are not significantly different at 5% significant level; p : Probability ; TS0, TS2, TS4, TS6 : *Trypsacum laxum*+ compound feed with 0, 2, 4 et 6% of spirulina; CFU: Colony Forming Unit

## Discussion

### Feed Intake By Guinea Pigs

Total DM intake was significantly higher in the supplemented animals. This is in agreement with the observations of Miégoúé et al. [2,5], Kouakou et al. [11], Ramirez-Riviera et al. [12], Peiretti and Meineri [18], Noubissi et al. [19] and Fotna [20] who showed that the inclusion of protein source increased feed intake. This result shows the good palatability of spirulina in guinea pigs. Indeed, Marie-Christine [21] showed that supplementation with spirulina in the diet of pigs, poultry and broilers improve their acceptability, palatability and digestibility. Moreover, with a good protein (60 to 70%), mineral value [22] and a low fiber value (2%) [21], spirulina might allow sufficient proliferation of micro-organisms. In the case of cellulolytic microflora, its nutrients would be better digested, thereby accelerating the digestive transit [2, 23]. This has the effect of pushing the animal to consume more. Indeed, Quigley and Poppi [24] showed that spirulina has the potential to increase the production of microorganisms and reduce its retention time in the rumen. Kana et al. [25] reported a reduction in dietary intake with the increased level of spirulina associate to 50% of cassava root waste in poultry. Feed intake and digestibility of nutrients were generally higher in animals supplemented with spirulina (TS2, TS4 and TS6). The inclusion of Spirulina increased acceptability, palatability and even digestibility in our

animals during the trial. The highest total DM feed intake (63.22 g DM/head/day) obtained was greater than 21.18, 56.8 and 50.61 g DM/head/day obtained respectively by Niba et al. [8], Miégoúé et al. [2] and Noubissi et al. [19], but lower than 73.7 and 103.21; 115.80 and 170.9 g DM/head/day) obtained by Kouakou et al. [11] and Egena et al. [23] and Miégoúé et al [2]. The observed difference could be attributed to the type of supplement used and to the quality of experimental feed. Supplementation increased total intake of dry matter but almost had opposite effect on ingestion of the compound feed. In fact, the ingestion of *T. laxum* was significantly higher in animals supplemented, than those of the control group. This observation contradicts those of Takele and Getachew [27] on sheep, Kouakou et al. [11] in guinea pigs fed *P. maximum* and supplemented with *Euphorbia heterophylla* and Noubissi et al. [19]. This can be explained by the fact that, protein intake of spirulina would have stimulated palatability of guinea pigs. Moreover, several works by Razafindrajoana et al. [22] and Marie-Christine [21] illustrated similar observation. The best feed intake of this grass obtained with the ration containing 4% spirulina (TS4) is explained by the fact that protein supplements would promote sufficient proliferation of intestinal microorganisms involved in in guinea pigs digestion. This could be related to the difference in chemical composition, notably the high CP content of *T. laxum* (1 3.86%) and fiber (37.77%) and its good palatability



by guinea pigs [9, 28].

#### *In vivo Digestibility in Guinea Pigs*

Apparent digestibility of dry matter (ADCDM) and organic matter (ADCOM) increased with the inclusion level of spirulina in the diet. This result is consistent with that of Miégoué et al [2, 5] who suggested that nitrogen (protein) supplementation improves DM digestibility by approximately 5 points, thereby improving the level of DM intake. Apparent digestibility of crude fiber (ADCCF) increased with increasing level of spirulina, which is corroborating with the observations of some authors [11, 12, 19] who used concentrate and *Tithonia diversifolia* as supplements. Also, low nitrogen intake in a low protein diet improves digestibility of cellulose [5]. Protein supplementation of poor forages ensures favorable conditions in the digestive tract, for the proliferation of cellulolytic microflora, microbial proteins and reduces transit time in the rumen in dwarf guinea goats. Total weight gains (TWG) and daily weight gains (DWG) obtained from the highest digestibility test (6.60 g and 1.32 g / d) were observed with TS4 animals group, but low in TS6 group. TWG and DWG of TS4 are correlated with feed intake and digestibility of animals of this group. On the other hand, the decrease of these parameters in the animals of group TS6 was inversely correlated with their feed intake and digestibility. This remark could indicate the supplementation of spirulina at 6% would have an adverse effect on guinea pig and therefore the optimum level would be 4%.

#### *Effects of Spirulina Level on the Caecal Flora.*

The caecal flora (lactobacilli, enterobacilli and salmonella levels) was not influenced by the incorporation of spirulina in guinea pig diet. This shows a balance between the bacterial caecal populations due to the experimental feed. [2,5] reported that stability of the caecal ecosystem is favored when the flow and nutrient composition entering the caecum is more stable. Moreover, the level of lactobacilli remained higher than that of enterobacilli irrespective of the ration. This corroborates with the observations made by Tsukahara [29], Miégoué et al. [5, 30]. These authors reported that, guinea pig normal flora is predominantly anaerobic gram (+), grams (-) being present in lesser

quantities. Spirulina can therefore be used as a source of protein in guinea pigs' diet without, however, running the risk of altering the composition of the caecal flora, which is generally unstable in order to ensure better digestibility of the nutrients. Losson [31] showed that a sudden change in the diet can lead to an imbalance of the flora that can lead to enteropathy. The lack of a significant difference in the caecal flora irrespective of the level of inclusion of spirulina can be explained by the chemical composition, especially their protein concentration, phycocyanin and carotenoids which modulate the colonization of the digestive tract by microbial populations. Our results are contrary to those of Rasmussen et al. [32] who reported that Spirulina supplementation stimulates the development of certain strains of Clostridia and alters Bifidobacteria populations. Spirulina supplementation therefore tends to modulate the colonization of the digestive tract by microbial populations involved in the gut microbiota homeostasis.

#### **Conclusion**

The effect of graded levels of spirulina on ingestion, *in vivo* digestibility and caecal flora of guinea pig (*Cavia porcellus*) were evaluated. From this study, it appears that the level of spirulina:

- Influenced intake of *T. laxum*, compound feed, dry matter (DM), organic matter (OM), crude fiber (CF) and crude protein (CP);
- Improved apparent digestibility of different nutrients;
- Did not influence caecal flora but allowed their balance by modulating different caecal flora populations;
- The administration of spirulina at the rate of 4% seem to be appropriate for guinea pig feeding but further investigation is necessary before using level above.

Spirulina is a blue-green algae that grows naturally on Lake Tchad and its use as an alternative source of nitrogen in guinea pigs fed on forage of low nutritional quality should be vulgarized.

#### **Conflict of Interest**

There are no conflict of interest among authors for this article.

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