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Anti-Obesity Effect of *Boscia senegalensis* in Rabbits

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Abstract

Introduction: Obesity is defined as excessive and abnormal accumulation of fatty tissue with significant somatic, psychological and social consequences on quality of life. Obesity has long been considered a simple aesthetic problem linked to excessive gluttony. It is however recognized today as a real pathology, so much so that the WHO has declared it as "the first non-infectious epidemic in history and a major problem of the century". In addition, many studies have been carried out aimed at the production of less fatty foods and, scientifically, at the development of anti-obesity drugs. Thus, the objective of this study is to evaluate the anti-obesity effect of the extract of *Boscia senegalensis* (Capparaceae) used in Chad to fight against type II diabetes and metabolic syndrome. **Methodology:** A bromatological study of *Boscia senegalensis* extract was carried out at the Food Quality Control Centre (CECOQDA) in Ndjamena (Chad), followed by an *in vivo* study of rabbits carried out at the IRED Biotechnopôle laboratory (Chad). **Results:** The results obtained from the 100 g bromatological study of the dry extract of *Boscia senegalensis* are as follows: protein content (20.24% ± 0.007%), fat content (5.92% ± 0.21%), carbohydrate content (35.16% ± 1.05%), fibre content (2.11% ± 0.26%), moisture content (5.7% ± 0.14%) and ash content (2.90% ± 0.03%). No aflatoxin was detected in the dry extract of *Boscia senegalensis.* A significant decrease ($p = 0.04$) in body weight was observed in rabbits treated with *Boscia senegalensis* extract compared to controls. In addition, histological sections of the various organs (liver, spleen, kidneys) of treated rabbits showed no lesions following the incorporation of the extract of *Boscia senegalensis*. **Conclusion:** This study showed the anti-obesity effect of *Boscia senegalensis.* It also made it possible to verify the harmlessness of the product with regard to the results

on chronic toxicity.

Keywords

Obesity, *Boscia senegalensis*, Toxicity

1. Introduction

Obesity is a major global public health problem because of its potential impact on health and its increasing frequency. It has reached the proportions of a global epidemic. Its development is very worrying because the number of obese adults continues to increase in developed countries; but it is also increasing alarmingly in developing countries ([1] [2] [3] [4] [5]). A 2017 WHO study reported that at least 2.8 million people die each year as a result of being overweight or obese [6]. In the Republic of Congo, the prevalence of obesity increased from 7.7% to 9.6% between 2010 and 2016 [7]. Indeed, obesity is characterized by the accumulation of excess body fat and can be conceptualized as the physical manifestation of a chronic surplus of energy [8]. Excess body fat promotes the induction of arterial hypertension, hypercholesterolemia, type II diabetes, coronary heart disease, gallbladder disorders, or even sleep apnea and osteoarthritis, which leads to a high risk of mortality ([9] [10]). Overweight and obesity are the fifth leading risk factor for death worldwide [11].

In the face of its scale and all its consequences, many strategies such as: the light strategies which consist of lifestyle changes such as weight loss and/or an increase in physical activity, heavy strategies, using drug or surgical treatments. To this we can also add dietary interventions, psychological interventions to change behaviour towards food intake [12]. However, these treatments are only accessible to a privileged category of populations because of their sometimes prohibitive costs, which makes the management of patients difficult. Under these conditions, many populations make use of medicinal plants to find a solution to their problem, but very few studies and innovations in Africa in general and in the Congo in particular lead to improved traditional medicines aimed at improving the health of people living with risk factors to develop diabetes or diabetes-disease itself. This is how a biophytomédicament was developed from a traditional *Boscia senegalensis* recipe used in Chad to fight type II diabetes and metabolic syndrome. In order to ensure the efficacy of this plant, our aim is to evaluate the effect of the extract of this plant on the variation of the rabbits' weight.

2. Materials and Methodology

2.1. Plant Material

Samples in the form of bare seeds of *Boscia senegalensis* (**Figure 1** and **Figure 2**).

Figure 1. Seeds of *Boscia senegalensis.*

Figure 2. Undressed seeds of *Boscia senegalensis.*

(Capparaceae) which were the subject of this study were bought at the Bokoro weekly market located 300 km east of Ndjaména (Chad).

Boscia senegalensis is a multi-stemmed shrub of the Capparaceae family with a height ranging from 2 to 3 m [13]. It is a ubiquitous species with a variety of anatomical devices that allow it to store the water it uses in the dry season, which gives it a good adaptation to the arid environment [14]. The species develops in the form of bush always green, with rounded and dense top. Its geographical area includes Burkina Faso, Cameroon, Ivory Coast, Ethiopia, Mauritania, Mali, Nigeria, Niger, Senegal, Sudan and Chad [14] [15] [16]. The fruits of *Boscia senegalensis* are spherical berries, usually between 12 and 15 mm in diameter, containing 1 to 4 seeds, which parts of the plant used in this study.

2.2. Experimental Animals

The experimental animals (n = 8) are rabbits of the "burgundy fauve" breed

from the IRED pet store. Young rabbits are three (3) months old and average weight about 1 kg. They are placed in cages 2 m long, 1.5 m wide and 1m high (4 animals/cage). During a 7-day acclimation period (20˚C - 26˚C), they are fed ad libitum with a standard food (Food formulated by the bromatology service of the IRED. Thus, each rabbit is entitled to 94.9 g of concentrate per day. This amount is significantly increased according to the growth of the rabbits. To this must also be added the sheets fresh panicum (herbaceous plant with the scientific name *Panicum maximum*). They have free access to drinking water.

3. Methodology

3.1. Bromatological Study

The protein content of the *Boscia senegalensis* seed powder was determined by the determination of nitrogen according to the standard KJELDAHL method [17]. The fat content was determined according to the SOXHLET method [18]. In addition, the fibre content of was determined by the WEENDE method [17] and the moisture content from the dry weight was obtained after passing the sample to the oven at 103˚C [19]. The process continued with the determination of the ash content by incineration [19]. Aflatoxins were determined by HPLC in accordance with European Standard 14,123 [20]. Finally, the total carbohydrate content was determined by copper determination using the BERTRAND method [21].

3.2. Maceration Extraction Method

The extraction process consisted of weighing 15 g of powder from the seeds of *B. senegalensis* obtained after mixing with a blender (Panasonic). The weighed sample was fed into a beaker containing 100 ml of distilled water. Once the mixture was homogenized, it was brought to a boil at 80˚C for 1 hour using a magnetic stirrer and then placed in a refrigerator for settling for 24 hours. The resulting solution was filtered with a sieve and the collected filtrate was then centrifuged. The dry extract obtained served as a solution for feeding rabbits.

3.3. Chronic Toxicity

Chronic toxicity was assessed over a 35-day period using the No Observed adverse effect level (NOEL) standard method. Two (2) batches of four rabbits each, of both sexes were formed. Each rabbit previously weighed, was marked with a marker at the ear to allow individual identification. To avoid pregnancy situations, females and males were not in the same cages. Treatment animals were deprived of water prior to treatment. Animals were weighed weekly. Every morning water and extract were administered by gavage. Rabbits each received 1000 mg of *Boscia senegalensis* extract per kg body weight per day for five weeks. During the treatment period (35 days), controls (four rabbits) were simply receiving distilled water.

After 35 days of feeding, the eight rabbits were sacrificed at the IRED pet

store. Once sacrificed, the organs were removed and stored in 100 ml vials containing formalin for a period of one month. Subsequently, the organs were brought to the anatomopathology laboratory of the Hospital and University Center of N'djamena for analysis.

Once in the laboratory, the organs were removed from the vials by the laboratory technicians, then cut transversely with a blade and placed in the cassettes to be placed in the inclusion automaton for cell fixation. Once out of the machine, they are paraffinized in blocks at the coating station. Which blocks are placed in the microtome for histological cutting in order to be spread on the blades and dried for about 20 min in the oven. Then they are stained with hematoxylin-eosin before microscopic observation and capture.

4. Results and Discussion

The results of the bromatological study are shown in the Table 1 below.

Table 1 provides information on the composition of some 100 g of *Boscia senegalensis*.

Thus, *Boscia senegalensis* extract containing 20.24% protein can be considered as a source of protein. From an energy perspective, *Boscia senegalensis* extract contains 35.16% carbohydrates. In terms of caloric intake, *B. senegalensis* extract contains 5.12% fat.

This study revealed protein content (20.24 ± 0.007), fat content (5.92% ± 0.21%), total carbohydrate content (35.16% ± 1.05%), fibre content (2.11% ± 0.26%), moisture content (5.7% ± 0.14%) and ash content (2.90% ± 0.03%). These results are similar to those obtained in 2007 [22]. Which obtained a protein content of 20.24; a total carbohydrate content of 49.67 per 100 g of the dry extract of *Boscia senegalensis*.

The results of the *in vivo* rabbit study are presented as follows.

Table 2 shows the variation in the weight of the animals after each week (S). These results clearly show the difference in the weight variation of the two batches before and after treatment. The calculated weight differences are illustrated by the curve in Figure 3 below:

Table 1. Physico-chemical composition of *Boscia senegalensis* extract (per 100 g of sample).

Parameters analysed (%)	Extract of *Boscia senegalensis* (100 g)
Moisture content (mean ± sd)	5.7 ± 0.14%
Ash (mean ± sd)	2.90 ± 0.03%
Protein (mean ± sd)	20.24 ± 0.007%
Total carbohydrates (mean ± sd)	35.16 ± 1.05%
Fat (mean ± sd)	5.92 ± 0.21%
Fiber (mean ± sd)	2.11 ± 0.26%
Other	27.97%

Table 2. Summary table of the variation in weight of rabbits treated with *Boscia senegalensis* extract versus untreated subjects.

No. of rabbits		Body weights of rabbits (g)						
		S-1	S0	S1	S2	S3	S4	S5
BS	1	1000	1103	1054	1140	1185	1235	1305
	2	972	1137	1186	1278	1250	1306	
	3	774	948	948	1067	1144	1212	1266
	4	902	903	906	1020	1081	1140	1187
	Moy	91200	1022.75	1023.50	1126.25	1165.00	1223	1252.67
	Et	10081	114.63	124.96	112.57	71.00	68.42	6012
	ΔMoy	0	110.75	111.50	214.25	253.00	311.25	340.67
	ΔEt	0	13.82	2415	11.76	29.81	32.39	40.69
CT	5	1453	1530	1595	1776	1847	1924	2005
	6	1123	1208	1273	1379	1397	1510	
	7	1272	1365	1480	1532	1595	1593	1555
	8	948	945	1070	1130	1206	1248	1271
	Moy	1199.25	1262.00	1354.50	1454.25	1511.25	1568.75	1610.33
	Et	214.57	248.89	231.79	271.03	274.45	278.76	370.12
	ΔMoy	0	62.75	155.25	255.00	312.00	359.50	411.08
	ΔEt	0	34.32	17.22	56.46	59.88	64.19	155.55

BS: *Boscia senegalensis*; CT: Control.

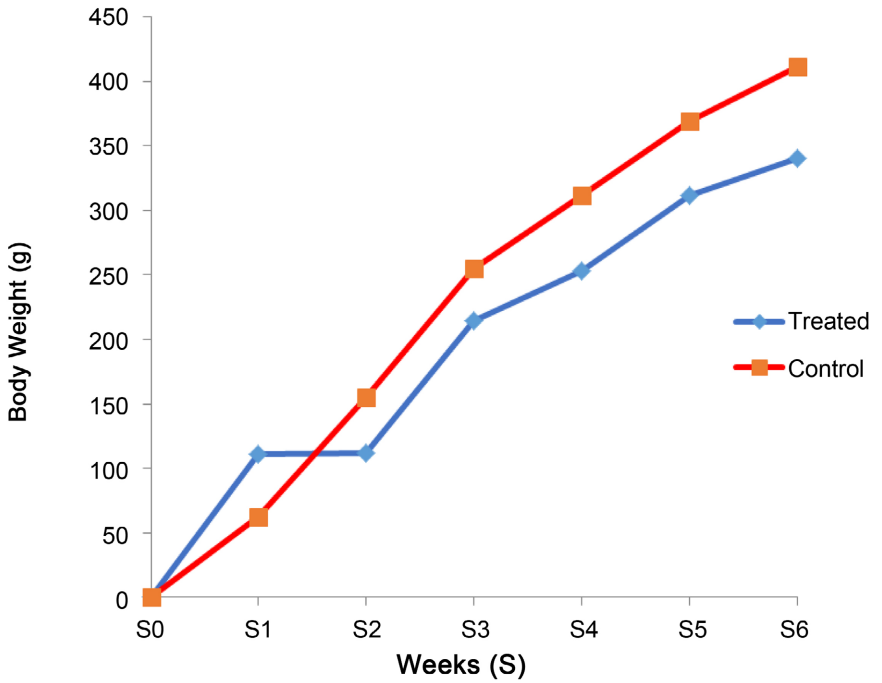

Figure 3. Evolution of body weight of rabbits treated with *Boscia senegalensis* extract (1000 mg/kg) compared to untreated rabbits.

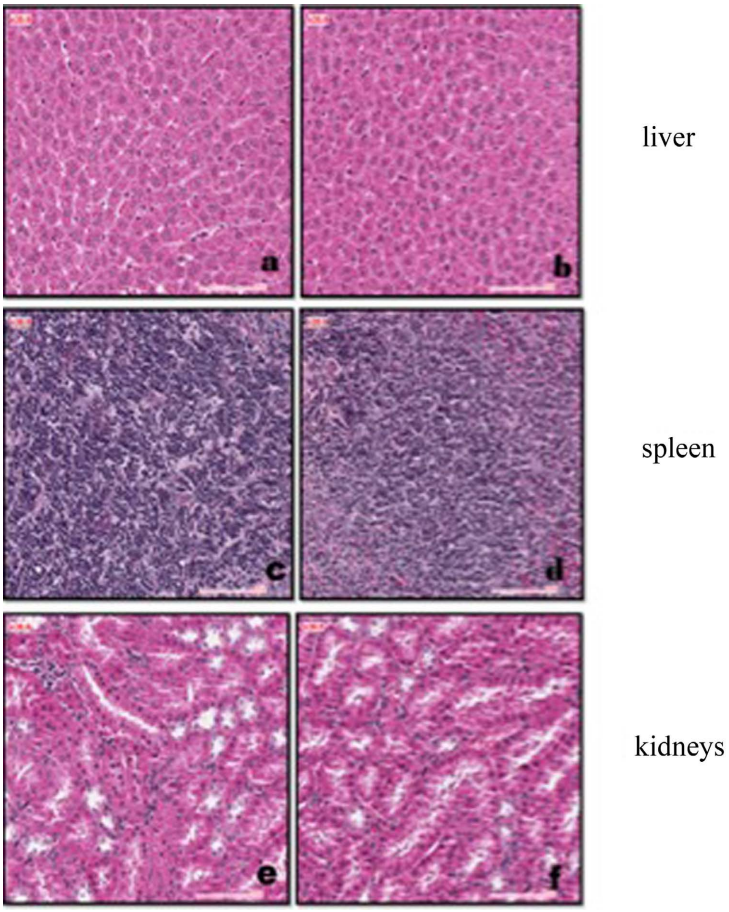

Figure 4. Histological cross-section of tissues of some organs of rabbits treated with *Boscia senegalensis* compared to those of control rabbits.

Indeed, from week S0 to S1, rabbits in both lots are subjected to the same diet. During this period, we find that the treatment lot rabbits have a much higher average weight than the control lot rabbits. Then a stall was observed from the first week of gavage (from week S1) in the treated lot materialized by a decrease in the body weight of these animals. This drop in weight resulting from the incorporation of *Boscia senegalensis* extract becomes persistent and significant ($p < 0.05$) between the treated and untreated (control) rabbits until the end of the experiment (**Figure 3**). However, it should be noted that rabbits in the control group normally believe throughout the experimental period. These results support earlier work by Bruno *et al.* (2013) on the effect of *Boscia senegalensis* extract on the growth of vigilant rats, thus confirming the effect of this plant on weight loss (PATENT INPI No. 2 991 181) [23].

Figure 4 shows the histological cross-section of tissues from different organs after 35 days of chronic administration of *Boscia senegalensis* extracts.

Sections of the liver, spleen and kidneys of the control animals (a, c, e respectively) were compared with those of the treated animals (b, d, f respectively). No tissue damage was observed in animals that received *Boscia senegalensis* extract. Therefore, *Boscia senegalensis* extract does not show any toxicity.

5. Conclusion

This study made it possible to show that *Boscia senegalensis* has an effect on weight variation materialized by a significant reduction in the weight load thus militating against obesity. It also made it possible to determine the composition of some essential nutritional elements of this food.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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