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Evaluation of appetite-stimulating properties of *Solanum torvum* berries in albino Wistar rats

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Abstract

Solanum torvum is a spontaneous food plant consumed in several regions in Côte d'Ivoire. The cooked berries of this plant are reportedly used in some rural areas to stimulate appetite in convalescing people. The objective of this study was to characterise the biochemical composition and to evaluate the appetite-stimulating potential of cooked *S. torvum* berries in anorexic rats. So, the berries were cooked in water for 30 minutes at 100 °C and analyzed for pH, titrable acidity, proteins, lipids, total carbohydrate, phenolic compounds, and β-Carotene determination. These berries were also administrated to anorexic 32 Wistar rats for 4 weeks. Appetite was assessed using parameters such as food consumed, water consumed, and body mass. The results show that *S. torvum* berries had a pH value that tends towards neutrality (6.84 ±0.01). Proteins, lipids, and carbohydrates values were respectively 10.018 %, 9.55% and 50.296 %. β-carotene was 88.37 µg/100 g FM. Polyphenols and flavonoids indicated values of 428.356 mg EAG/g and 3.236 mg EQ/g, respectively. The aqueous extracts of *S. torvum* berries at the concentration of 6.4 mg/mL increase water and food consumption. It also allows a greater gain in rats' body mass. A high concentration of *S. torvum* berries could improve appetite.

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Introduction

The interest in plant foods has increased following epidemiological studies relating to eating habits and the prevalence of certain diseases (cancers, obesity, cardiovascular diseases). The main nutritional interest of these plants lies in their supply of minerals, vitamins and dietary fiber. Their daily consumption allows a satisfactory dietary balance.

However, in some sick people, there may be a decrease or loss of appetite. Loss of appetite is a common condition, mostly benign, but sometimes it can be the result of a more serious illness. Proper nutrition is necessary to combat both nutritional deficiencies and chronic diseases. In order to treat ailments, prevent diseases and help people who lack tone and body mass, it is recommended to slowly awaken the appetite of sick subjects. Thus, it is possible to resort to certain plants such as *Capsicum annuum* and *Solanum torvum* (wild eggplant). Indeed, *Capsicum annuum,* in addition to its anti-hemorrhoidal action, is used as a stimulant of appetite and nutrition (Jouzier, 2005). Also, the use of *Solanum torvum* berries in appetite stimulation was reported in an ethnobotanical study by Choudhury *et al.* (2015) in India.

In Côte d'Ivoire, most of the information collected mentions the use of *Solanum torvum* fruits and leaves in traditional medicine for the treatment of malaria (Asase *et al.,* 2010), hypertension (Amiot-Carlin *et al.,* 2007) and anemia (Gbogbo *et al.,* 2021). In addition, the moderate inhibitory action of the fruits of this plant on alpha-glucosidase makes it suitable for use as an anti-diabetic (Takahashi *et al.,* 2010). Indeed, the methyl caffeate isolated from *Solanum torvum* is reported to possess a hypoglycemic effect and could be developed into a potent oral anti-diabetic drug (Gandhi *et al.,* 2011). Its fruits are an excellent source of natural antioxidants such as quinones, flavonoids, coumarins and vitamin C (Amiot-Carlin *et al.,* 2007). It could be an effective nutritional supplement able to fight against oxidative stress. However, all these studies have not focused on its ability to stimulate appetite.

It is, therefore, opportune, in view of the resurgence of diseases in the Ivorian populations, to evaluate the physicochemical composition of *S. torvum* berry as well as its capacity to stimulate appetite in the albino Wistar rat.

Materials and methods

Collection of plant material

S. torvum berries were collected in a forest at Diegonefla in the department of Oumé, a town about 260 km from Abidjan in central-western Côte d'Ivoire. These berries were collected three weeks after flowering from trees over one meter tall. The berries were stored in a cooler and then transported to Abidjan.

Animal material

Thirty-two (32) rats of the species *Rattus norvegicus* of the Wistar strain, including 16 males and 16 females, aged 8 weeks old with an average body mass of 105 g, were used for the experiment.

These rats were acclimatized for one week to the rearing conditions of the physiology, pharmacology and pharmacopoeia laboratory of the Nangui Abrogoua University (Côte d'Ivoire). They had free access to water and food.

Preparation of S. torvum aqueous extracts

S. torvum berries were removed from the stems, weighed, and washed. They were then cooked in water for 30 minutes at 100 °C in the proportions described by Agbemafle *et al.* (2012). After cooking, the mixture (berries and water) was ground with an immersion blender. Part of the resulting grind was used for biochemical assays to be performed on the fresh sample and the other part dried. Ten grams (10 g) of dried sample was then dissolved in 0.3 L of distilled water.

The resulting mixture was homogenized in a magnetic stirrer for 24 hours. The resulting homogenate was successively filtered twice on cotton wool and once on Wattman No. 1 filter paper. The filtrate was then freeze-dried and stored for experiments.

Physico-chemical analysis of S. torvum berries extracts

The pH and titratable acidity of the aqueous extract of *S. torvum* berries were determined using a pH meter. Protein content was evaluated according to standard methods (AOAC, 1990). The Soxhlet method was used to determine the total lipid content (AOAC, 1990). The total carbohydrate content was determined according to the formula described by Bertrand and Thomas (1910) expressed as:

Total carbohydrate =100 - [Fat (%)+ Protein (%)+ Water (%) + Ash (%)].

Phenolic compounds were extracted with a hydroalcoholic methanol/water mixture (90:10; v/v) (Bala *et al.,* 2014). The contents of β-Carotene, polyphenols and flavonoids were determined by UV-Visible spectrophotometry (Model V-530, Jasco International, Tokyo, Japan) according to the methods of Tee *et al.* (1996) at 450 nm, McDonald *et al.* (2001) at 765 nm and Chang *et al.* (2002) at 415 nm, respectively.

Experimental protocol

The appetite stimulation test was conducted on 4 groups of 8 rats each. Prior to the experiment, the rats were rendered anorexic after 4 days of treatment with an anorectic pharmaceutical product named *Abat l'appétit*. The rats were subsequently subjected to oral treatment as follows:

Group 1: control negative rats were given 1 ml/100 g/day of distilled water by gavage.

Group 2: control positive rats were given 1 ml/100 g/day of Nurabol by gavage, a reference pharmaceutical product that stimulates appetite;

Group 3: rats were given 1 ml/100g/day of *S. torvum* extract at a concentration of 3.2 mg/mL;

Group 4: rats given 1 ml/100g/d of *S. torvum* berry extract at the concentration of 6.4 mg/mL by gavage.

Appetite was assessed using parameters such as food consumed, water consumed, and body mass at day 0 (just before experimentation or week 0), at the end of week 2, and at the end of week 4.

Statistical analysis

Data were collected from the analysis of biochemical parameters of cooked berries of *S. torvum* with 3 replicates. The results were expressed as mean ± standard deviation. XLSTAT 7.1 software was used to process the data using analysis of variance (ANOVA) followed by a Tukey post hoc test. Differences were considered significant if $p < 0.05$.

Results and discussion

Physico-chemical parameters

Table 1 shows the values of physico-chemical parameters of *S. torvum* berry. The titratable acidity of *S. torvum* berries was 36.666 meq/100g with a pH value that tends towards neutrality (6.84 ±0.01). The aqueous extract could therefore contribute to the acid-base balance of the organism. Contents of total protein and β-carotene were 10.018 % and 88.37 µg/100 g FM, respectively. The total lipid content was 9.55 % and total carbohydrates 50.296 %, while those of polyphenols and flavonoids indicated values of 428.356 mg EAG/g and 3.236 mg EQ/g, respectively.

The protein content obtained in our study is significant for a vegetable. Indeed, it is higher than those reported by Koua *et al.* (2016) for the fruits of *Solanum aethiopicum* (scarlet eggplant), which is 1.5 %, *Solanum macrocarpon* (Gboma aubergine) (1.4 %) and *Solanum melongena* (purple aubergine) (0.8 %). *S. torvum* berries also contain β-carotene despite their green colour being masked by chlorophyll. However, this β-carotene content is lower than those reported by Grubben *et al.* (2004) in raw *S. torvum* berries, i.e., 390 µg /100g MF. This low level could be due to the cooking process in water which causes micronutrient losses. Lipid levels in *S. torvum* berries are also around 10 %. This could be explained by the nature and quantity of the berries. Lipids give a smooth and creamy texture to food. The lipid content is higher than that found by Grubben *et al.* (2004) in *S. torvum* berries, i.e., 0.4 %. This difference may be due to climatic conditions, harvest time, cultivation technique and variety. The polyphenol content of *S. torvum* berries is high (428,356 mg GAE/100 g). These phenolic compounds are of interest because they are becoming essential elements of the diet in prevention. Indeed, they inhibit or slow down the oxidation of a substrate (Waterhouse, 2014). However, these levels are lower than those reported by Dan *et al.* (2014) in raw *Solanum anguivi* berries, which is 956.70 mg EAG/100 g. These differences could be due to variety, soil type, cooking, exposure to sunlight and level of ripening at harvest, which influences the polyphenol content of foods (Manach *et al.,* 2004).

Table 1. Physico-chimical composition of cooked *S. torvum* berries.

Parameters	Quantity
Titratable acidity	36.666 ± 5.77
pH	6.843 ± 0,01
Protein (%)	10.018 ± 0.05
β-Carotene (µg/100 g FM)	88.370 ± 1.65
Total fat (%)	9.550 ± 0.79
Total carbohydrates (%)	50.296 ± 2.50
Polyphenols (mg EAG/g DE)	428.356 ± 25.134
Flavonoids (mg EQ/g DE)	3.236 ± 1.778

Each result is expressed as mean ± standard deviation (n=3)
DE: mean Dry extract.
FM: mean fresh matter

The flavonoid content of *S. torvum* berries is low (3,236 mg EQ/g). These low levels may be due to cooking. Indeed, Agbo *et al.* (2020) revealed a decrease in flavonoid content from 660 mg EQ/g to 117.67 mg EQ/g in potato leaves after steaming for 20 minutes.

Appetite test

Water consumption

The volume of water consumed did not vary significantly between batches during the experiment. However, in the second and fourth weeks, an increase in water consumption was observed in rats treated with the aqueous extract of *S. torvum* at the concentration of 6.4 mg/mL compared to controls (Fig. 1).

Food consumption

Fig. 2 shows an increase in feed consumption in all experimental batches without significant variation.

Similarly, the aqueous extracts of *S. torvum* berries resulted in a non-significant increase in feed intake compared to the controls.

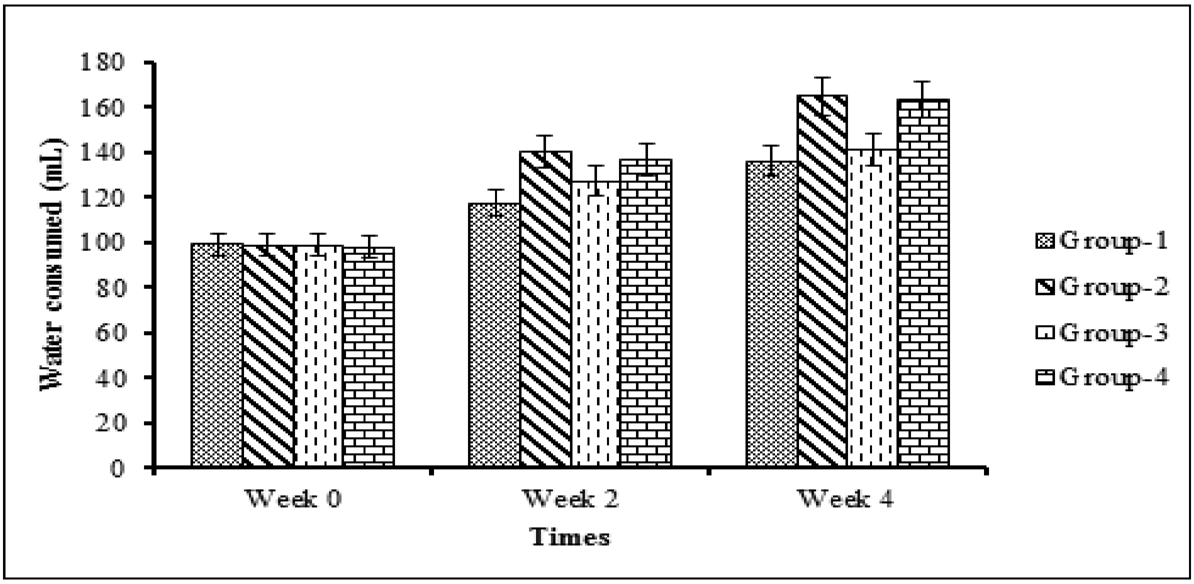

Fig. 1. Variation of water consumption over time in rats.
n=8, p > 0.05 (no significant difference).

Body mass
Fig. 3 shows weight gain over time in the different groups of experimental rats without significant difference. However, a greater gain in body mass was recorded in the groups treated with the reference product and *S. torvum* extract at the concentration of 6.4 mg/ml compared to the negative control group at the end of the second and fourth week.

The aqueous extract of *S. torvum* berries caused an increase in food and water consumption in treated rats compared to control rats. But this increase was not significant, indicating that *S. torvum* berries could have the same effect as the pharmaceutical reference product to stimulate appetite. However, this result is not sufficient to corroborate Jouzier's (2005) claim that *S. torvum* berries stimulate appetite in India. In fact, there are plants that have been confirmed to have appetite-stimulating properties. This is *Trigonella foenum-graecum* (fenugreek), whose use as an appetizer for weight gain has been studied in children aged 3-5 years by Hadi (2018).

In contrast, the consumption of plants such as *Allium sativum* is likely to be an appetite suppressant. Indeed, Gatsing *et al.* (2005) observed in their work a decrease in food consumption after administration of 300 mg/ kg body weight of the aqueous extract of *Allium sativum* to rats. In addition, the treated animals drank as much water as the controls.

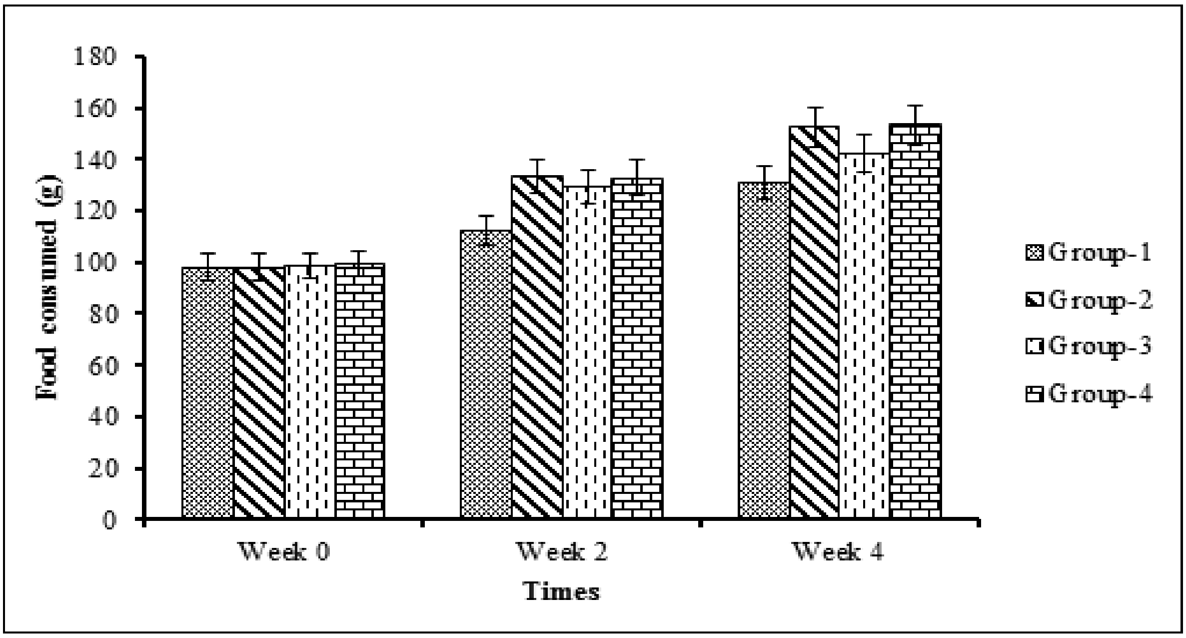

Fig. 2. Variation of food consumption over time in rats.
n=8, p > 0,05 (no significant difference).

Weight changes are an indication of the general health of the animal. The results did not indicate a significant increase in body weight gain in rats treated with *S. torvum* compared to the control.

These observations are consistent with the results regarding food and water consumption in the same rats during the study. These results are also observed in the work of Koné *et al.* (2009), who showed that daily administration of the aqueous extract of *Sacoglottis gabonensis* (Baille) Urban (Humiriaceae) for 28 days in rats did not result in a significant change in food and water consumption as well as weight gain. The amounts of food and water consumed in the treated rat groups can be correlated with bodyweight gains. This is also reflected in the work of Gbogbo *et al.* (2014), who showed little weight gain with increased food and water intake in rats after repeated administration of the total aqueous extract of *Spondias mombin* stem barks with the doses of 500 and 1000 mg/kg bodyweight for 28 days.

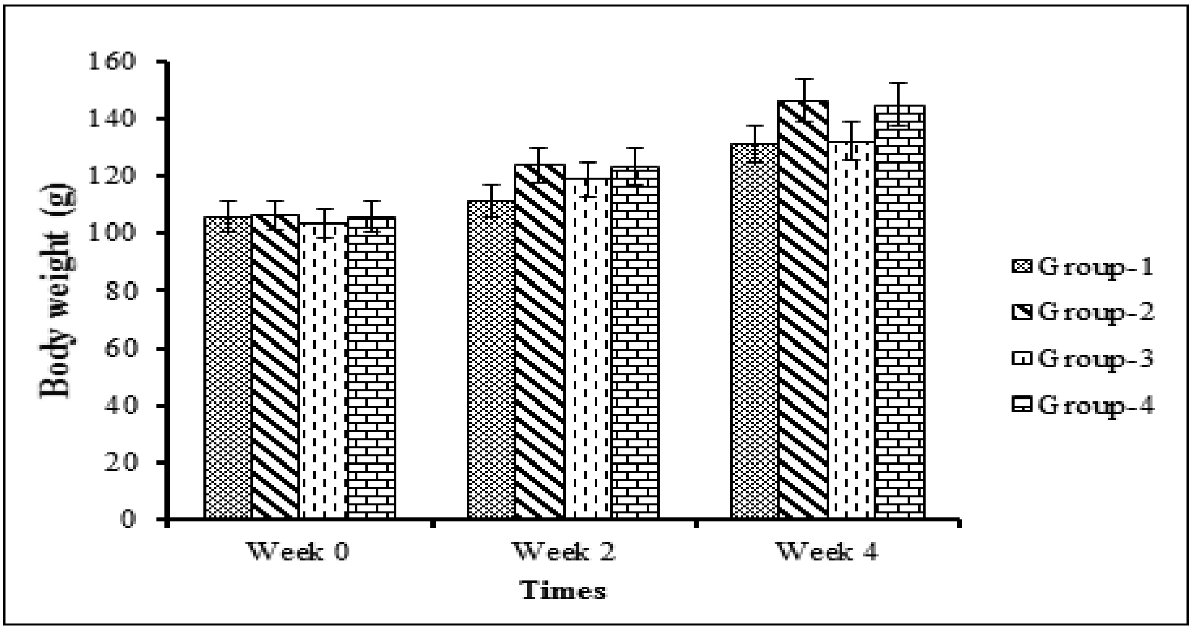

Fig. 3. Changes in body mass of rats over time.
n=8, p > 0.05 (no significant difference).

Conclusion

This study showed that cooked *Solanum torvum* berries have an important nutritional contribution due to their protein content and secondary metabolism. The stimulating properties of the berries of this plant in rats exist as it could have the same effect as pharmaceutical reference products if the consumption stimulation is increased. However, to better understand this phenomenon, peptide digestive hormones such as leptin and ghrelin, related to appetite, should be evaluated in further studies.

Conflict of interest statement

The authors declare that they have no conflict of interest.

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