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(RESEARCH ARTICLE)

# Ethnobotanical study and effect on mice weight gain of four plants used during famine in Burkina Faso: *Raphionacme daronii, Gardenia erubescens, Leptadenia hastata* and *Balanites aegyptiaca*

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## Abstract

Overweight and obesity are pathologies that increase dramatically, they are most often associated with diseases such as hypertension, heart failure, stroke, type II diabetes, insulin resistance, dyslipidemias, certain cancers etc .The objective was to conduct an ethnobotanical survey of 4 plants consumed during periods of hunger and to determine the effect of the extracts of these plants on weight gain and food intake.The survey was based on direct dialogue using the respondent's choice language and the use of a questionnaire. Acute toxicity was determined on NMRI mice by orally administering of single dose of 2000 mg/kg. The slimming and anorectic potential of plant extracts was to evaluate the effect of plant extracts on weight gain and food intake of animals treated at 50, 100 and 500 mg/kg. 55 person with an age between 40 and 81 years old were interviewed. *Raphionacme daronii* gave the highest frequency of citation with 25.42%. All plant species showed no toxicity at 2000 mg/kg. *Gardenia erubescens* at 50 mg/kg gave a good activity on weight gain with a reduction of 5.18% against the control with an increase of 11.02%. *Gardenia erubescens* at 500 mg/kg gave the best anorectic activity on the treated animals.These plant extracts are an asset in the search for a new natural and less toxic molecule for the fight against obesity.

**Keywords:** Overweight; Ethnobotanical survey; Food intake; *Gardenia erubescens*

## 1. Introduction

Obesity, called a global epidemic by the World Health Organization (WHO), has indeed multiple harmful effects as well on the sanitary level as economic and human. In fact, obesity is a serious public health problem throughout the world. It is a risk factor for various chronic health conditions such as cardiovascular disease, type 2 diabetes and some cancers [1]. These diseases not only lead to a decline in quality of life because of their chronic nature, they also lead to serious complications and premature death [2]. To remedy this, several means are used such as physical exercises, dietetics, surgical treatments, pharmaceutical drugs, herbal medicine, etc....

Plants have always been the main source (up to 90%) of drugs or care for the treatment of various pathologies of the population in many African countries [3]. Burkina Faso, like Sahelian countries, has often been confronted in times of famine [4]. During these periods of food shortage, people usually resort to plants that have appetite suppressant effects. These provide them with satiety, usually without significant energy, which can lead to weight loss. So taking a supplement of these appetite suppressants may help you lose weight by reducing appetite and cravings. The activity of these plant species is certainly related to the presence of metabolites such as glycosilated pregnanes [5], mannans [6], caffeine [7,8], mucilage, phenylalanine [9,10], which can cause anorexia, reduce triglycerides or inhibit the enzymes involved in lipid metabolism such as pancreatic lipase, lipoprotein lipase and glycerophosphate dehydrogenase or to increase energy expenditure. All these mechanisms result in a reduction of fat mass and thus body weight.

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*Raphionacme daronii, Gardenia erubescens, Leptadenia hastata, Balanites aegyptiaca* are four (4) plants consumed during periods of scarcity. The fruits of *Gardenia erubescens* contain carbohydrates, fibers [11], they are also rich in anthraquinones, tannins, sterols and triterpenes [12]. The tuber of *Raphionacme daronii* contains sugars and starch [13]. *Leptadenia hastata* (Pers.) Decne contains glucosides, steroidal saponins, triterpenes, flavonoids, mucilage, sterols, tannins [14]. Phytochemical investigations carried out on *B. aegyptiaca* revealed the presence of several classes of secondary metabolites such as flavonoids [15], coumarins [16], steroidal saponosides [17].As part of this study, the objective was to conduct an ethnobotanical survey on these plants and to determine the effect of the extracts of these plants on weight gain and food intake of animals.

## 2. Material and methods

### 2.1. Ethnobotanical survey

The surveys were conducted in the two provinces of Burkina Faso where there are traditherapeutes, nomadic populations or hunters during the period from September to October 2016. The survey was conducted on four (4) species of plants frequently used during periods of famine, namely, *Raphionacme daronii, Gardenia erubescens, Leptadenia hastata, Balanites aegyptiaca*. The approach was based on a dialogue using the respondent's choice language and the use of a questionnaire. A field trip was organized and the plants mentioned in the interview were collected with the help of the respondent. The survey data were processed by Excel software and plant quotations frequencies calculated using the following formula:

$$\mathrm{F} = \frac{\text{person who cited the plant specie}}{\text{total person interviewed}} x\ 100$$

### 2.2. Biological material

The fruits of *Gardenia erubescens, Balanites aegyptiaca,* leaves of *Leptadenia hastata* and tubers of *Raphionacme daronii* were harvested in Toma (northwestern Burkina Faso) and Dori (northeastern Burkina Faso) during the growing season (October 2016). The species were authenticated by Professor Millogo R. Jeanne, botanist at the University of Ouagadougou. The samples were dried under laboratory conditions, sheltered from the sun, then pulverized and stored in freezer bags for different extractions. The fruit and tuber pulps were kept in the freezer.

Male and female mice (NMRI) from the pet shop at the University of Ouagadougou ; Burkina Faso were acclimated for one week (25 ° C with a circadian cycle) for various *in vivo* tests.

### 2.3. Extraction

The samples were extracted by ethanolic maceration, so 50 g of *Leptadenia hastata* leaves powder were extracted in 500 ml of pure ethanol. For *Gardenia erubescens, Balanites aegyptiaca, Raphionacme daronii;* the fruit and tuber pulps previously stored in the freezer were milled, then 50 g of the ground material of each sample is placed in 500 ml of pure ethanol. These different mixtures obtained were stirred for 24 hours. The extracts obtained are concentrated using a rotary evaporator equipped with a vacuum pump. The concentrate was dried in an oven and kept for carrying out the different tests.

### 2.4. Assessment of the acute toxicity of plant extracts

Acute toxicity was determined according to the method described by OECD [18]. The animals are fasted for 12 hours, then the weight of each mouse is taken and they receive a single dose of extract (2000 mg/kg of body weight). The extracts were administered orally by gavage to the different test batch against a control batch that received only water. The signs of toxicity (writhing, panic, moribund state, death ...) were noted by group after 2h, 24h, 48h, 72h and the animals are kept under observation for two weeks.

### 2.5. Slimming and anorectic potential of plant extracts

It consisted of evaluating the effect of plant extracts on weight gain and food intake of treated animals. The study used the method described by Van Heerden and al. [5].

#### *2.5.1. Animal treatment*

The study uses mice aged 5-6 weeks. The mice are divided into four (4) groups of six (6) mice each. These group received doses of 50, 100 and 500 mg/kg body weight of an extract preparation that was administered daily to the animals orally

and the negative control group that received only the vehicle (water). The mice are placed 12 hours in the light, 12 hours in the dark and have free access to food and water. They were treated for a period of 4 weeks.
Group 1: Gavage with water
Group 2 : Gavage with plant extracts at 50 mg/kg body weight
Group 3: Gavage with plant extracts at 100 mg/kg body weight
Group 4: Gavage with plant extracts at 500 mg/kg body weight
Composition of animal food
Protein (26%), corn starch (50%), sucrose (9%), soybean oil (5%), cellulose (5%), mineral mixture and vitamin (5%).

*2.5.2. Slimming potential (weight gain)*

It consisted in determining the effect of the extract on the weight of the treated animals. During the experience period, the body weight of each animal was measured every three days using a standard weighing device. The net weight gain was calculated: Net weight gain = final weight - initial weight.

*2.5.3. Anorectic activity of the extract (food intake)*

It consisted of determining the effect of the extract on the amount of food taken from the animals. The aim was to measure the total amount of food remaining per weigh each day for each batch. Food consumption = total amount of food given - amount of food remaining.

## 3. Results

### 3.1. Ethnobotanical survey

During the survey we interviewed 55 people between the ages of 40 and 81 years old; more than 50% of whom are between 50 and 70 years old. The number of years of practice experience varies between 7 and 35 years. Men accounted for 92.72% of our respondents compared to 07.27% of women and they were traditional healers, herbalists, hunters and certain person with knowledge of plants. *Raphionacme daronii* gave the highest frequency of citation (Table 1).

**Table 1** Results of ethnobotanical survey

| | **local name** | **Frequency** | **Part used** | **Indication** | **Mode of use** | **Other use** |
|---|---|---|---|---|---|---|
| *Raphionacme daronii* | Goin | 25.42% | Tuber | Against hunger | Raw consumption of tubers | Tubers are used against thirst<br>Sexual impotence |
| *Gardenia erubescens* | Kouin or Souboudga | 20.34% | Fruits | Against hunger | Raw consumption of tubers | The bark is used against yellow fever, stomach ache |
| *Leptadenia hastata* | Toun or Tatola or Belongo | 10.16% | Leaves | Against hunger | Raw consumption of tubers | The leaves are used against thirst, diarrhea, cough, infertility |
| *Balanites aegytiaca* | Tanèè or sinbèlè | 10.16% | Fruits | Against hunger | Raw consumption of tubers | Fruits are eaten to fight against stomach ache The bark is used against malaria and scorpion bites |

### 3.2. Acute toxicity

Oral gavage was the method of administering the extracts of the four (04) plants used. On batches of six (06) mice we did not observe any mortality or signs of intoxication after seventy two hours (72 h) of observation following the administration of the extracts (Table 2).

**Table 2** Results of plants toxicity

| Plants | Dose | Number of Mice uses | Number of deaths after | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2h | 24h | 48h | 72h | % of death after 72h | Signs of toxicity |
| *Raphionacme daronii* | 2000 mg/kg.bw | 06 | 00 | 00 | 00 | 00 | 00 | No sign of toxicity |
| *Gardenia erubescens* | 2000 mg/kg.bw | 06 | 00 | 00 | 00 | 00 | 00 | No sign of toxicity |
| *Leptadenia hastata* | 2000 mg/kg.bw | 06 | 00 | 00 | 00 | 00 | 00 | No sign of toxicity |
| *Balanites aegyptiaca* | 2000 mg/kg.bw | 06 | 00 | 00 | 00 | 00 | 00 | No sign of toxicity |

bw= body weight

### 3.3. Effect of extracts on the weight of treated animals

Figure 1,2,3,4 shows the effect of *Leptadenia Hastata, Balanites aegyptiaca, Raphionacme daronii and Gardenia erubescens* on the weight of animals treated at 50, 100 and 500 mg/kg bw. The weight in control animals is increasing throughout the experiment. *Leptadenia hastata* at 50 mg/kg caused a weight reduction of the treated animals compared to the control group at doses of 100 and 500 mg/kg. *Balanites aegyptiaca* at 500 mg/kg reduces the weight of the animals as shown by the shape of the curve (fig 2). Weight in control animals is increasing throughout treatment. At the end of the experiment the 500 mg/kg extract reduced the weight by 0.8% compared to the initial weight (Fig. 5 (2)) while the control gave a growth of 11.02%. For *Raphionacme daronii* extract, the 100 mg/kg weight dose exhibited the best activity with a weight reduction of 3.91% compared to a 5.83% increase in the control (Fig 6 (1)). Extract at 50 and 500 mg/kg showed good activity compared to the control. For *Gardenia erubescens* extract the best activity was obtained with the dose of 50 mg/kg. At this dose it causes a reduction of 5.18% (Fig. 6 (2)). The 500 mg/kg extract also causes weight reduction in the treated animals.

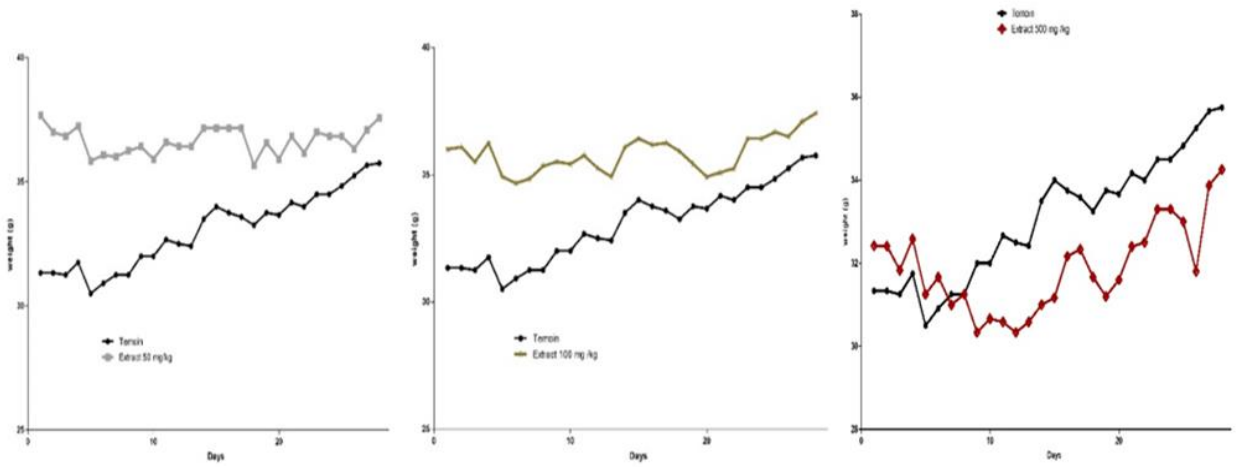

**Figure 1** Effect of *Leptadenia hastata* extracts on the weight of treated animals

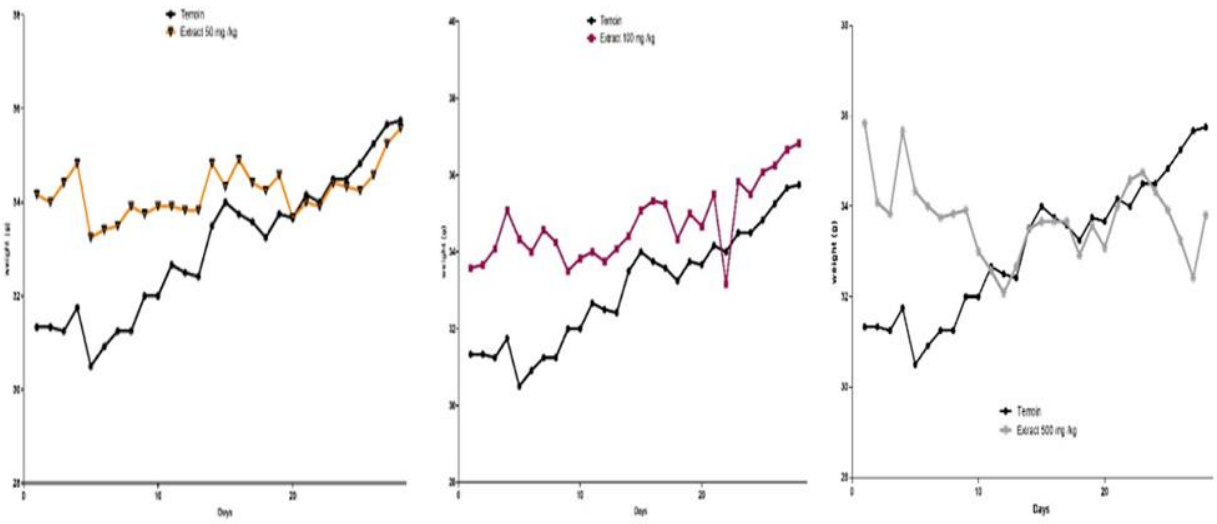


**Figure 2** Effect of *Balanites aegyptiaca* on the weight of animals

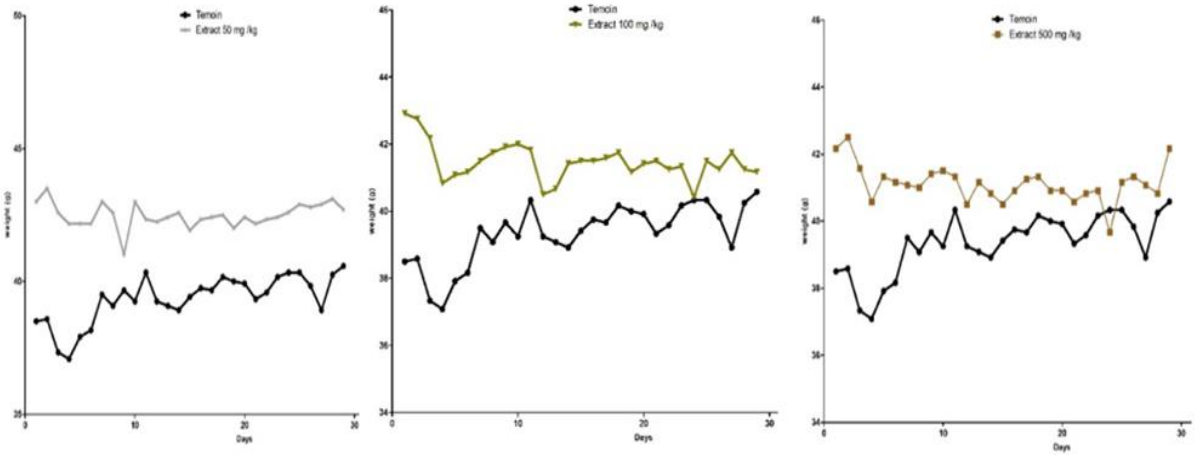


**Figure 3** Effect of *Raphionacme daronii* on the weight of animals

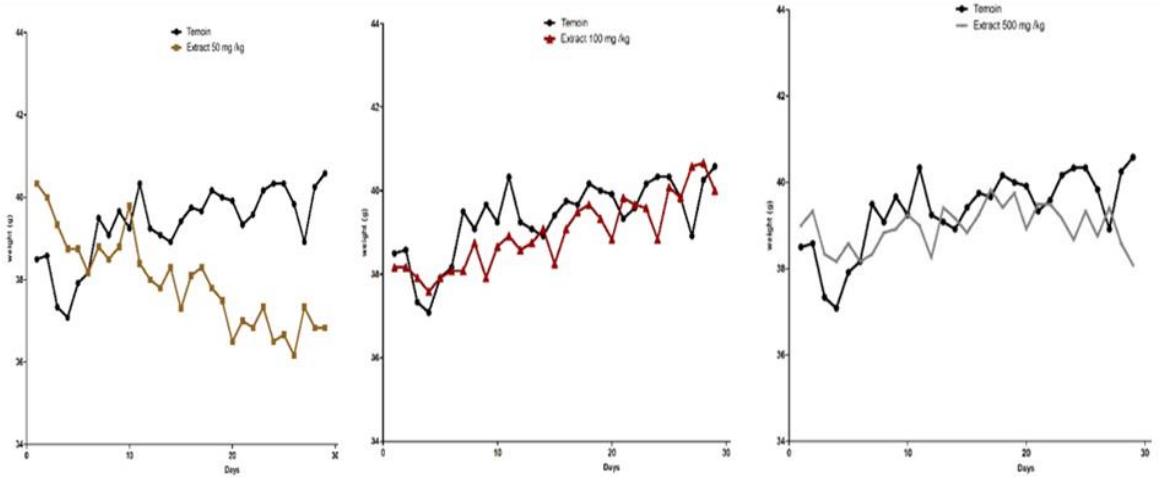


**Figure 4** Effect of *Gardenia erubescens* on the weight of animals

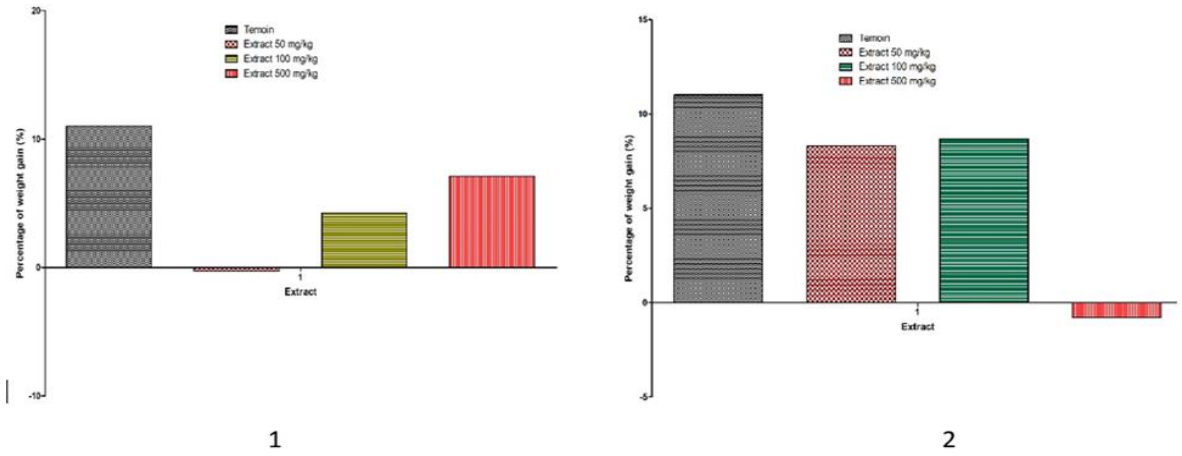


**Figure 5** Weight reduction percentage of *Leptadenia hastata* (1) and *Balanites aegyptiaca* (2) extracts

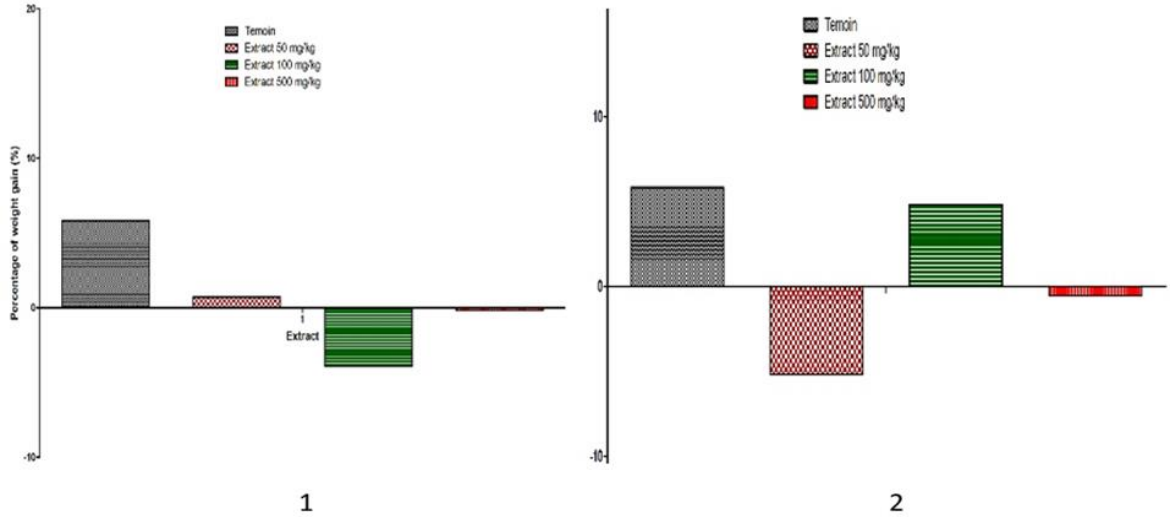


**Figure 6** Weight reduction percentage of *Raphionacme daronii* (1) and *Gardenia erubescens* (2) extracts

### 3.4. Anorectic effect of animal extracts

Figure 7 shows the effect of extracts of *Leptadenia hastata*, *Balanites aegyptiaca, Raphionacme daronii* and *Gardenia erubescens* respectively. The administration of *Leptadenia hastata* extract at 50, 100 and 500 mg/kg to the animals caused a reduction in food intake compared with the control which showed an increase in food intake. The extract at 50 and 100 mg/kg gave the best activities. With regard to *Balanites aegyptiaca* extract, the 100 mg/kg dose gave the best activity compared to the control group and those receiving 50 and 500 mg/kg body weight. *Raphionacme daronii* extract at 50 and 100 mg/kg had no effect on the amount of food taken, unlike the 500 mg/kg extract which caused a significantly different reduction in food intake than witness. *Gardenia erubescens* at 500 mg/kg gave the best activity on Food intake reduction.

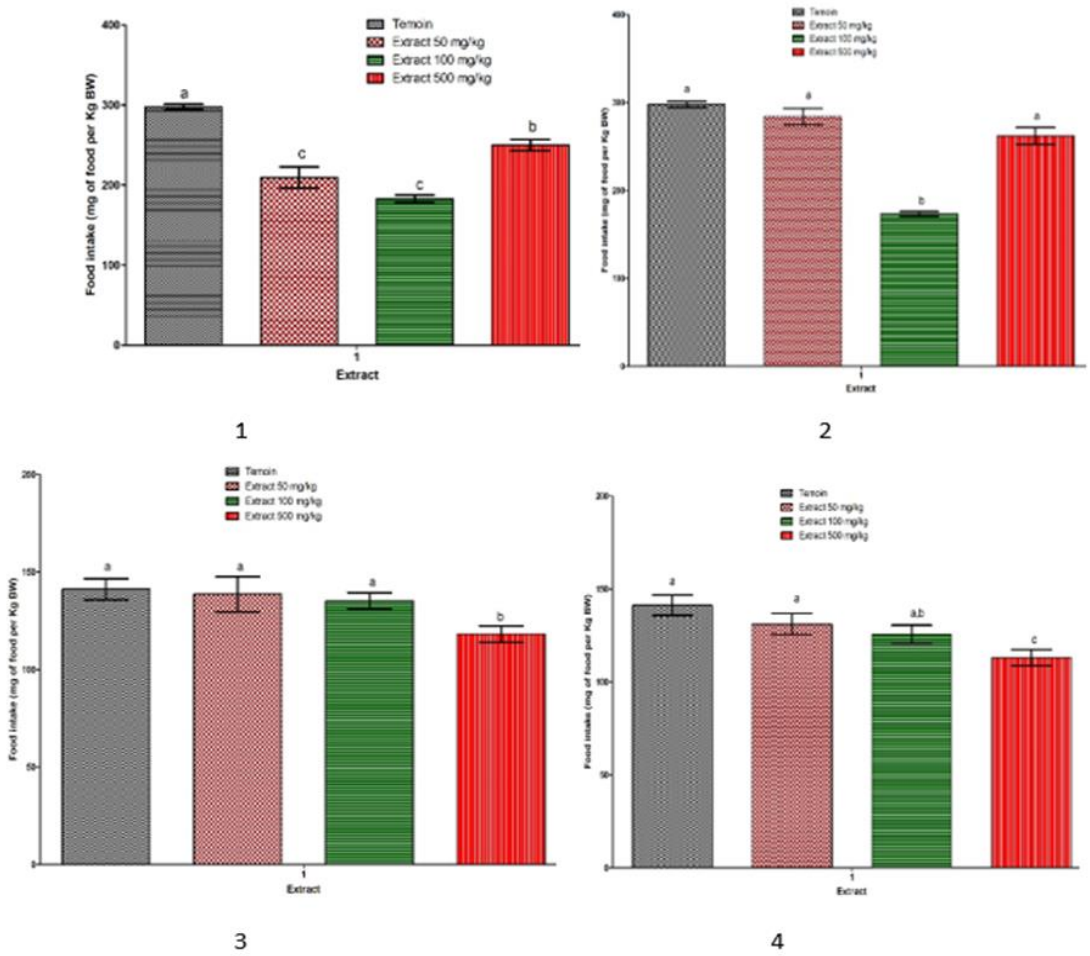


**Figure 7** Food consumption per kg of body weight of treated animals (1=*Leptadenia hastata*, 2=*Balanites aegyptiaca*, 3=*Raphionacme daronii*, 4=*Gardenia erubescens*) Values are expressed as mean + S.D. Means with different letters in a row differ significantly (P>0.05)

## 4. Discussion

The 4 species of plants namely *Leptadenia hastata, Balanites aegyptiaca, Raphionacme daronii* and *Gardenia erubescens* are all used in Burkina Faso during periods of famine. *Raphionacme daronii* gave the highest frequency of use. Millogo-Rasolodimby et al. [19] also found during their ethnobotanical surveys that leaves of *Leptadenia hastata*, young leaves and fruits of *Balanites aegyptiaca* are species of starvation plants consumed in Burkina Faso. Diarra et al. [20] have shown in their ethnobotanical study conducted in Mali that the fruits of *Gardenia erubescens* and the tuber *Raphionacme daronii* are used during the lean periods.

Administration of the ethanolic extracts of plant species to 2000 mg/kg body weight in mice showed no signs of toxicity. According to the OECD [18] these extracts are very low in toxicity. This could explain the consumption of these species by the populations. Bayala et al. [21] found that *Leptadenia hastata* is not toxic up to 4000 mg/kg. Our results corroborate those of Suky et al. [22] who also showed that *Balanites aegyptiaca* showed no toxicity at 2000 mg/kg.

*Gardenia erubescens* at 50 mg/kg gave the best activity among the extracts of the 4 plants on weight reduction. This good activity could be explained by the presence of sterols and triterpenes [12]. Certain molecules such as ursolic acid, a pentacyclic triterpene of *Sambucus australis* reduces abdominal adipogenesis in obese mice [23]. The extract is not dependent dose, the activity at 50 mg/kg of the extract is greater than that of 100 and 500 mg/kg, this could be explained by the presence of an effective dose which is 50 mg/kg. The other three extracts showed a good weight reduction compared to the control. *Leptadenia hastata* is rich in glucosides, steroidal saponins, triterpenes, flavonoids [14]. *Balanites aegyptiaca* have demonstrated the presence of several classes of secondary metabolites such as flavonoids [15], coumarins [16], steroidal saponosides [17]. Flavonoids in the extracts may explain the reducing effect of weight in treated animals. Some flavonoids are known to reduce obesity. Resveratrol (Stilbenoid) and genistein (Isoflavone)

produce a reduction in weight by their adipocytes apoptosis inducing action [24]. Rutin, quercetin, naregenine inhibit the activity of glycerol-3-phosphate dehydrogenase (GPDH) and the expression of genes involved in the differentiation of adipocytes, thus preventing their proliferation [25]. Thus causes a reduction in weight.

Extracts of *Leptadenia hastata* at 50, 100, 500 mg/kg, *Balanites aegyptiaca* at 100, 500 mg/kg, *Raphionacme daronii* at 500 mg/kg and *Gardenia erubescens* at 100, 500 mg/kg showed an anorectic effect compared with witness. Aquino et al. [26] isolated polyoxypregnanes in the extract of *Leptadenia hastata*, also five glycosylated steroids were isolated from *Balanites aegyptiaca* fruits by Farid et al. [27]. Triterpenes and flavonoids were highlighted in the extract of *Balanites aegyptiaca*.

The anorexigenic activity observed in plant extracts is due to the presence of a compound such as glycosylated pregnanes and flavonoids. At present, the glycosilic pregnans isolated in *Hoodia gordonii* have an action in the central nervous system. It would mimic the effects of glucose on the hypothalamus, which would then send messages of satiety to the body. The molecule would have an action ten thousand times greater than that of glucose without bringing any calorie [28]. Triterpenes could also inhibit the secretion of ghrelin hormone orexigen and reduce food intake [29].

## 5. Conclusion

In conclusion the results of our study indicated that *Leptadenia hastata, Balanites aegyptiaca*, *Raphionacme daronii and Gardenia erubescens* are used in Burkina Faso against hunger in times of scarcity. The extracts of these plants are not toxic and they have an effect on the reduction of weight gain and food intake. These plant extracts are an asset in the search for a new natural and less toxic molecule for the fight against obesity. They could help to regulate weight gain in people with obesity that is gaining momentum in developing countries.

## Compliance with ethical standards

### *Acknowledgments*

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### *Disclosure of conflict of interest*

Authors have declared that no competing interests exist.

### *Statement of ethical approval*

All experimental animal protocols had complied with the instructions of the Institutional Animal Ethics Committee (directive 2010/63/EU on protection of animals used for scientific purposes). Ethical approval code: 2010/63/EU, Date of approval: 20 October 2010. The institutional animal ethical guidelines were strictly observed. All authors hereby declare that "Principles of laboratory animal care were followed, as well as specific national laws where applicable.

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