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## Abstract

**Background:** The *Phoenix dactylifera* L. (date palm) is known for its traditional medicinal properties across the history of native population in Algerian Sahara. There is a large trend of consumption of date palm pollen preparations in many human infertility cases in our country. However, the validity has not been scientifically tested. There has been no direct scientific research on this application. This study was undertaken to identify cultivars with greater potential in the traditional medicine uses. To evaluate the effects of date palm pollen on some sexual behavioural parameters of male adult rats, we tested the role of pollen powder from Deglet Nour cultivar on some male reproductive parameters.

**Materials and Methods:** An Ethnobotanical survey was conducted in 17 oases in southern Algeria to identify all cultivars with medicinal interest. Local people were interviewed with open questions. A questionnaire and personal interviews for data collection were designed to record important cultivars, parts used and preparations. To determine the active constituents of date palm pollen used in traditional medicine, a phytochemical screening was performed. The effects of oral administration of date palm pollen suspension on male adult rats were investigated on body and testicle weights, serum testosterone level.

**Results:** 131 prominent cultivars were found within 12 cultivars containing various parts with medicinal effects. Some primary and secondary metabolites were detected by phytochemical screening. The pollen increased the weight of the body, testicles and enhanced the serum testosterone level of male rats treated.

**Conclusion:** The present survey has provided the identification and recognition of date palm cultivars used in traditional Saharan medicine. Date palm pollen could improve sexual activities in male infertility cases and may be attempted to derive drugs.

**Key words:** Algeria; Cultivars; Date palm; Date palm pollen effects; Ethnobotanical survey; Medicinal properties.

## Introduction

Infertility is becoming a serious health problem in Algeria. It affects about 12% of Algerian couples. Among couples received in endocrinology services, male infertility accounts for 50% (Haiba et al., 2014). Most of them have resorted to using herbal substances, such as date palm pollen, which has been shown to have an aphrodisiac effect. In recent decades, the usage of herbal preparations has become more popular in sterility cases and the use of date palm pollen, mixed with other preparations, is more common in arid areas. Various parts of the date palm, used in traditional medicine, are gaining importance and are being studied to find the scientific basis of their therapeutic actions (Ali et al., 1999; De la Calle et al., 2001).

The date palm grows well in arid and semi-arid regions of Africa, Asia, and in some Mediterranean climate regions of Europe, North America, and Australia.

In Algeria, *Phoenix dactylifera* L. is cultivated in the northern Sahara (Algerian Ministry of Agriculture, 2009); the main date palm areas are located in the provinces of Biskra, El Oued, Adrar, Ghardaia, and Ouargla (Hannachi et al., 1998). The beneficial health and nutrition values of this "blessed tree" have been underlined since centuries, because of the antioxidant properties of the fruit and pollen (Vayalil, 2002; Mohamed and Al-Okbi, 2004; Allaith, 2005).

Pollen of date palm is a natural herbal powder widely used in traditional medicine to cure both male and female sterility. It is used in prostatitis for treatment and prevention of weakness of sexual activity due to low function of testicles or a disturbance of their hormonal control (De la Calle et al., 2001), or abnormalities in production of sperm in testicles (Dor et al., 1977). It is obvious that spermatogenesis relies on hormonal control; testosterone and FSH are considered to have an important effect in all phases (Simoni et al., 1999). Although, their role remains elusive, their combination seems important for induction and maintenance of normal sperm production. On the other hand, testosterone is able to enhance the activity of the seminiferous tubule Sertoli cells (Griswold, 2005).

This study was designed to assess, through an ethnobotanical survey in the oases, the recognition of cultivars with medicinal interest among the identified cultivars and to ascertain the traditional uses of date palm pollen for therapeutic purposes.

Currently, there are no scientific reports on the relationship between traditional medicinal use of date palm pollen in Algerian oases, and their effects on human health.

The survey has allowed the identification of 12 cultivars with different parts (dates, pollen, inflorescences, leaves and seeds) used in traditional therapeutic practices and their potential use in the pharmaceutical field. The most significant remedy has highlighted the importance of pollen to enhance male sexual reproduction.

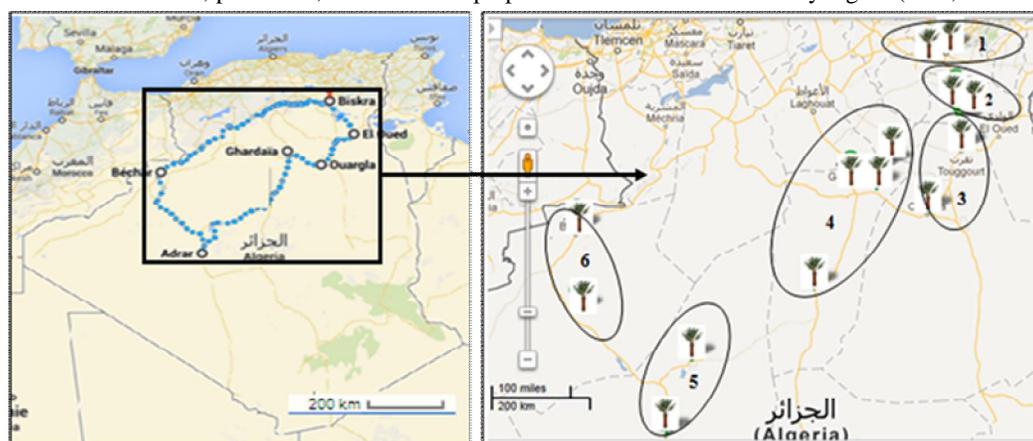
The effect of date palm pollen is studied on male adult rats; this experiment was therefore aimed to evaluate the possible action of date palm pollen administration on some parameters of male sexual behaviour of rats (body and testicle weight changes with the serum testosterone level variation).

## Materials and Methods

### Study area and ethnobotanical information

A field survey was carried out, using a questionnaire to gather information on the cultivars used in traditional medicine among identified cultivars. In this survey, 131 women (41%) and 185 men (59%) aged between 17- 69 of indigenous people were interviewed. Several visits were carried out over 3 years (2011–2014) during spring and fall, at temperature range of 15-28 °C.

Several palm groves were visited in 6 provinces covering three main date palm areas, oriented as follows: South-East, South-West and Central Sahara (**Figure 1**). The ethnobotanical information was recorded and analyzed to determine local cultivar name, parts used, the method of preparation and the formulation by region (food, medicines).



**Figure 1:** Map of study area showing the geographical distribution of date-growing areas surveyed in southern Algeria (Google maps, modified).

(1) **Zibans:** Biskra-Tolga, (2) **Oued Souf:** El Oued- Aghefiane -Al meghaier-Djamaa, (3) **Oued Righ:** Ouargla-Touggourt, (4) **M'zab:** Berriane- Ghardaïa- Guerrara- Zelfana- El menia, (5) **Touat:** Adrar- Timimoun, (6) **Saoura:** Bechar- Beni Abbes.

### Sampling of plant material

The spadices were harvested from healthy male date palms (*Dokkars*). The pollen derived from dried mature male spadices dusted through of 1mm mesh sieve, then carefully stored in confined containers and kept in darkness at 0°C. A homogenized suspension was prepared from pollen powder dissolved in sterile distilled water.

### Phytochemical screening of date palm pollen

To determine the composition of date palm pollen primary and secondary metabolism, the pollen grains were dried under shade (25°C). The aqueous extract was prepared by macerating pollen powder at 20% in boiled distilled water. After shaking and filtration, the dilute solution was treated with various solvents to ascertain the different phytoconstituents (Wagner, 1983; Bruneton, 2009). The qualitative results are expressed by colorimetric reactions or precipitation (**Table 1**).

**Table 1:** Colorimetric reagents used in identification of some primary and secondary metabolites.

Primary and secondary metabolites	Chemical reagents	Colorimetric reactions
Glycosides	H <sub>2</sub> SO <sub>4</sub>	Purple
Starch	Iodine (I <sub>2</sub> )	Blue-violet
Tannins	FeCl <sub>3</sub> 5%	Blue black
Cathechin tannins	Stiany Reagent	Blue black
Gallic tannins	Sodium Acetate + FeCl <sub>3</sub>	Black blue
Saponins	HCl (0,1N) + NaOH (0,1N)	Foam formation
Flavonoids	Hcl + Mg (magnesium metal) + Isoamyl-Alcohol	Orange-red

### Influence of date palm pollen on sexual male reproduction

#### Selection of rats

A total of 30 male adult albino rats (200g weight) were chosen through the animal house of Research and Development Center (Saidal, Algiers) and maintained in cages under standard laboratory conditions (temperature of 22–24 °C, 50% humidity, and a photoperiod of 12h).

3 groups of 10 rats each (control group, experimental group I, and experimental group II), subjected to a monitored diet [measured amount of the granulated food “feed pellets” containing glucids (49, 80%), proteins (23, 5%), lipids (5%), and vitamin Mineral complex (5, 7%), added to a volume of tap water *ad libitum* ].

#### Treatment of rats with the suspension of pollen

Pollen suspension used in feeding rats was prepared by dissolving an amount of pollen powder in a volume of sterile distilled water. Two different doses (120 mg.kg<sup>-1</sup> and 160 mg.kg<sup>-1</sup>) were adjusted according to adult rat body weight, called Experimental groups I and II.

As was previously reported, 120 mg.kg<sup>-1</sup>, 140 mg.kg<sup>-1</sup> and 240 mg.kg<sup>-1</sup> have been tested (Bahmanpour et al., 2006; Abedi et al., 2012; Iftikhar et al., 2014). Feeding gavage was used with 2ml of date palm pollen suspension once a day for 50 consecutive days. The control group was treated with tap water. Food (feed pellets) was weighed before and after in order to measure consumption of each. Moreover, all changes in rats behaviours were noted (diarrhea, constipation, fever, etc.).

#### Tissue sample collection

During the experiment, rats were weighed and recorded at 10 day intervals (0-50 days). At the end of 50 days, the rats were anesthetized and safely sacrificed before dissection. After the last dose on the 50<sup>th</sup> day of treatments, the male reproductive organs (testicles) of both control and experimental groups were dissected out, separated, weighed and stored at -80°C.

#### Collection of blood and testosterone assay

At the end of the experiment (after 50th days of treatment), blood samples (2ml) of both control and experimental groups were collected by capillary action from the eyes, using capillary tubes, centrifuged at 3000 rpm for 10 minutes. The clot was removed and the clear serum was carefully separated into the eppendorf tube, stored in a dried ice and then used for the determination of testosterone levels. The testosterone levels of blood serum were measured by immunoassay method. The testosterone analysis was conducted by an automated mini VIDAS<sup>®</sup> instruments “Bio-Merieux, France” (Medical Avicenna Laboratory, Algiers), for the quantitative determination of total testosterone in serum or plasma using the ELFA technique (Enzyme Linked Fluorescent Assay).

#### Statistical analysis

A statistical analysis was carried out by a two-way analysis of variance (ANOVA) test, using statistical software program (Statistica version 6). Quantitative data were expressed as mean ± SD, the significance of the difference between means was determined by Post-Hoc Tukey's HSD at P ≤ 0.05, P ≤ 0.01. D'Agostino-Pearson omnibus test was applied to assess normality of the data, a significant level of skewness above normal (P ≤ 0.05) was considered.

The study was approved by the ethics committee of the Center of Research and Development (SAIDAL). During the experiment, the health of the rats was of paramount importance.

## Results

### Ethnobotanical study

A total of 131 cultivars from 17 date palm groves (oases) in the Eastern, Central, and Western Sahara of Algeria were identified (**Table 2**). Twelve cultivars were known for their use in folk medicine by the native populations of the different oases. **Figure 2** shows the morphology of the fruits from 9 named cultivars mainly used in traditional medicine: Deglet Nour, Feggous, Ghars, H'mira, Oucht, Taddela, Takerboucht, Tanetboucht, and Timdjouhart.

**Table 2:** Cultivars of Date palm identified in southern Algeria where the ethnobotanical survey was carried out (17 oases).

<b>Palm groves (Total number of identified cultivars)</b>
<b>Cultivars with medicinal effects in bold.</b>
<b>Adrar- Timimoun (8)</b> Bamekhlouf- Feggous- H'mira- Ouarglia- Takerboucht- Takerboucht Beidha- Takerboucht Hamra- Takerboucht Safra.
<b>Bechar- Beni Abbes (14)</b> Adham Boula- Adham Tirnou- Adhamet El Rob-Cherka-Deglet Talmine- <b>Feggous-H'mira</b> -Hartan-Kenta-Khomira-M'charet- Takerboucht- Timliha-Tinnaser.
<b>Biskra-Tolga (10)</b> Arechti- Degla Beidha- <b>Deglet Nour</b> - El Guettara- Ghars- Ghazi- <b>Mech Degla</b> - Tanetboucht-Tinicine-Zoggar Moggar. <b>El Oued- Al meghaier-Djamaa- Aghefiane (37)</b> Abd El Azzaz- Adham Deglet Nour-Alig- Aliyane-Ammari-Arechti-Bachair-Baidir-Beidh H'mam-Bouarous-Boukhnous-Chetaya-Degla Beidha-Deglet Djitou-Deglet Nour-Dfar Elgat-Dguel El Hadj-Dguel M'ghas-Dimoulou- <b>Ghars</b> -Halimi-Halwa(Halwaya)-Kesba-Khodri-Loulou-Masri-Sokrya-Tachelilt-Tacherwint-Tachlikt-Takermoust-Takhedrayt-Tanetboucht-Taoudent-Tarmount-Zaghraya-Zehdi.
<b>Ghardaïa- Berriane- Guerrara- Zelfana- El menia (37)</b> Adham Bent Q'bala- Ajujil-Baydir-Bent Q'bala- Bouarous(Ouarous)- Chikh-Degla Beidha-Degla Beidha-Deglet Djdir- <b>Deglet Nour</b> -Gachouch- <b>Ghars</b> - Hartan-H'mira- Ighes n'cheikh-Itima- Naser Ou Salah- <b>Oucht</b> -Sab'a Bedraa- <b>Taddela</b> (El Dala) -Tademamt-Tafezwin-Takerboucht (Akerbouch)-Takermoust-Tamesrait-Tamezouaret-Tanagarout- <b>Tanetboucht</b> -Tawragha- <b>Tazerzayt</b> -Tazizawt-Tiaaka-Tiguezza- <b>Timdjouhart</b> -Timedwel-Tinnassert-Tissibi.
<b>Ouargla (04)</b> Deglet Nour-Ghars- Takermoust-Tanslit.
<b>Tougourt (21)</b> Aliyane – Beidh H'mam-Bentqala-Bouldjib-Degla Beidha-Deglet G'rara- Deglet Mechta-Dguel El Hadj- El Kaber-El Kaid- Ghars-Halwa (Halwaya)-Hamraya-Tafezwin-Takermoust- Tanetboucht-Tanslit-Taoudanet-Tawragha- Tazegakht (Hamraya)- Tinicine.



**Figure 2:** Morphological characteristics of 9 cultivar fruits used in traditional medicine.

1. Deglet Nour, 2. Feggous, 3 .Ghars, 4. H' mira, 5. Oucht, 6.Taddela, 7.Takerboucht, 8.Tanetboucht, 9.Timdjouhart (scale bars =2 cm).

### Use of date palm in folk medicine

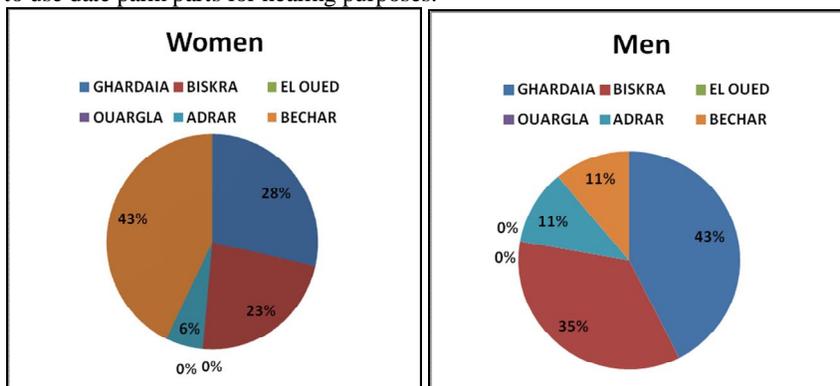
Among 17 oases surveyed, Ghardaia showed the highest percentage of the practice of traditional medicine that use date palm in the treatment of the most common diseases (**Figure 3** and **Table 3**). On the other hand, people from Ouargla and El Oued oases showed no interest in traditional medicine.

**Table 3:** Listing of date palm cultivars used in traditional medicine in southern Algeria.

Palm groves	Cultivars name	Parts used	Diseases, therapeutic effects
Ghardaïa	Deglet Nour	Dates	Diarrhea
	Deglet Nour (Dokkar)	Pollen	Male and female sterility
	Ghars	Leaves	Cough
		Dates	Injuries, constipation, hypertension, edema, dizziness, gastric ulcers
	Oucht	Dates	Easy delivery, hemorrhage
	Taddela	Leaves	Cough
	Tanetboucht	Dates	Cancer
	Tazerzayt (Dokkar)	Pollen	Male and female sterility
	Timdjouhart	Leaves	Cough, sore throat
	Other cultivars	Dates syrup	Skin healing, blood sugar, pain of sore, gum
Biskra		Seeds	Fortifying, weakness, gout disease, lactation
	Deglet Nour	Dates	Blood sugar, hypertension
	Ghars	Pollen	Male and female sterility

	Mech Degla Other cultivars	Dates Seeds	Broken arms, legs or back and elderly Gout disease
<b>Bechar</b>	Feggous H'mira	Dates Dates	Brown spots on the skin Beauty mask
	Bamekhlouf	Dates	Bites of scorpions
<b>Adrar</b>	Takerboucht, other cultivars	Dates Pollen	Dizziness Male and female sterility

According to the gender of respondents, it was revealed that men used date palm medicines more often than women (**Figure 3**). Based on the age of respondents, it was found that those aged 40 and over, regardless of gender, were most likely to use date palm parts for healing purposes.



**Figure 3:** Percentage of Saharan people using the date palm parts in traditional medicine in different date palm groves.

### Cultivars and traditional uses

The traditional use of date palm parts in folk medicine depends on the oasis population. The most important cultivars researched for treatment of male and female infertility are Deglet Nour and Tazerzayt. Depending on the region visited and the mode of preparation, many formulations have been used in the pharmacopoeia (**Table 3**). According to the Saharan opinions, date palm pollen is used to enhance sexual activity in both men and women. The most popular recipe is the mixture of pollen powder with bee honey eaten after fasting, daily, at least 2 hours before breakfast. It is recommended to women to take it during the ovulation period.

Another method is widely used by sprinkling pollen grains mixed to herbal extracts upon a sanitary towel during the fertile phase of menstrual cycle to improve ovulation and fertilization of women. Women interviewed have reported the beneficial role of this preparation to clean the uterus and induce its wetness.

On the other hand, dry or soft dates are widely used by the Saharan population against many health troubles by eating the entire fruit or crushing it into a powder and mixing it with butter or milk. This mixture is applied on broken arms, legs, or back for the elderly, advised as beauty aid for a young bride to eliminate dark spots of the skin by spreading it on the whole body.

In South-Eastern oases as Ghardaia (**Table 2**), dates from Ghars cultivar are used against diarrhea and gastrointestinal diseases. In addition, those from Oucht cultivar are recommended to pregnant women, especially just before giving birth to their babies.

In contrast, in South-Western oases, dates from Bamekhlouf cultivar (Adrar oases) are used to treat scorpion bites. Also, those from Feggous and H'mira cultivars (Bechar oases) are advised for human beautification.

In parallel, leaves of Taddela and Timdjouhart cultivars (Ghardaia oases) are mostly purposed in the treatment of respiratory diseases, lungs, cough and cold. However, seeds from cultivars of Biskra oases are generally used to boost health and strength.

### Phytochemical screening

A phytochemical analysis of date palm pollen has revealed the presence of primary metabolic compounds as glycosides and starch and secondary metabolites like saponins (high amount) and gallic tannins (weak amount), and the total absence of flavonoids and catechin tannins as shown in **Table 4**.

**Table 4:** Phytochemical composition of date palm pollen.

Chemical compounds	Amounts recorded	
<b>Primary metabolites</b>	Glycosids	+++
	Starch	++
<b>Secondary metabolites</b>	Saponins	+++
	Gallic tannins	++
	Flavonids	-
	Mucilage	-
	Cathechin tannins	-

+: weak amount, ++: moderate amount, +++: high amount, -: total absence.

### Date palm pollen effects on male albino rats

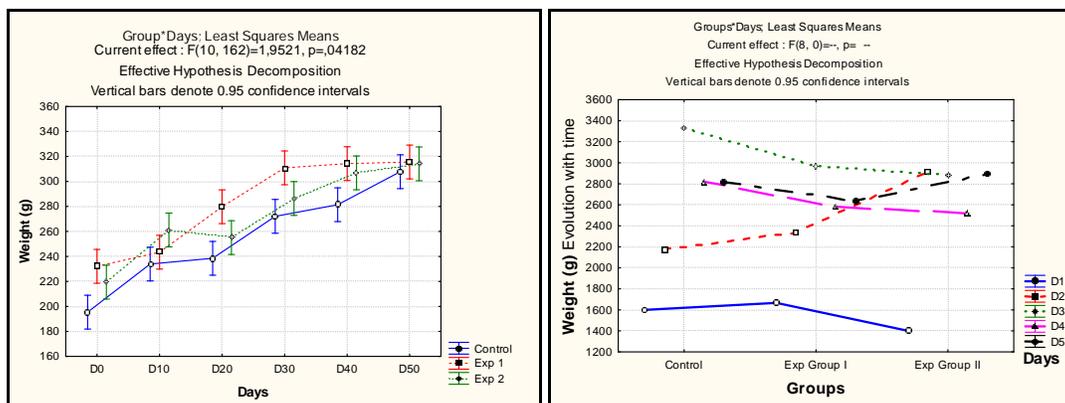
Examination of rats used for these experimentations has showed that they were healthy without any ailment.

### Body weight variation

Data analysis showed that the weight of rats rises with pollen treatment in all experimental groups as compared to the control group, but the most effective dose was 120 mg.kg<sup>-1</sup>. For the control group, the weight was 195, 4 g before treatment, it became 307,8g after 50 days of application with an average of 254, 85±13,15g.

Body weight of experimental group I and II were varied respectively from 232, 1 g to 315,6 g and 232,1 g to 315,6 g with an average of 282,68±13,50g and 273,85±11,64g.

The difference in the body weight of animals in Control group and Experimental groups I and II was statistically significant  $p < 0.05$  (Figure 4).



**Figure 4:** Variation of body weight (4.1) and the amount of food intake by rats (4.2) over 50 days. (Control: without treatment, Experimental Group I: 120 mg.kg<sup>-1</sup>, Experimental Group II: 160 mg.kg<sup>-1</sup>, n= 10 rats in each group, Significant difference at  $P < 0.05$ . **D10:** 10 days, **D20:** 20 days, **D30:** 30 days, **D40:** 40 days, **D50:** 50 days).

A comparison of the mean body weight of the rats before, during and after treatment revealed that both the control and experimental groups caused an increase in body weight.

However, ANOVA followed by Tukey HSD Test underlined the obvious increase of rat body weight by the dose 120 mg.kg<sup>-1</sup> compared to 160 mg.kg<sup>-1</sup>.

Regarding the duration of treatment, 30 days appeared sufficient because the body weights of rats in the control and experimental groups were stable and no significant changes were recorded till day 50 (Figure 4).

Concerning the quantity of food (feed pellets) taken by rats in each treatment, an enhancement of the food amount taken by rats was noted with time (10, 20, 30 days). It has increased exponentially during the first month. After 30 days, it has decreased for all groups.

### Testicle weight

The data obtained from the mean testicular weights of the control and experimental groups I and II date palm pollen-treated rats are given in Figure 5, using Post-Hoc Tukey's HSDT and D'Agostino-Pearson omnibus Tests ( $P \leq 0.05$ ).

For the right testicle, in the control group, the value of weight is varied from 1,385 to 1,619 g in control group with an average of  $1,48 \pm 0,0865g$ , and respectively for experimental groups I and II; 1,526 to 1,804 g with an average of  $1,67 \pm 0,1106g$  and 1,452 to 1,975 g with an average of  $1,71 \pm 0,1906g$ .

On the other hand, for the left testicle, the testicular weights are ranged from 1,275 to 1,692g in the control group with an average of  $1,45 \pm 0,1256g$ . The experimental groups testicular weights vary from 1,519 to 1,956 g with an average of  $1,74 \pm 0,1500g$  (experimental group I) and from 1,524 to 1,915g with an average of  $1,68 \pm 0,1356g$  (experimental group II).

According to the position of testicles, there were no significant changes between the weight of the right and left testicles in both control and experimental groups, while the testicular weights seem enhanced by date palm pollen doses as  $120 \text{ mg.kg}^{-1}$  at ( $P \leq 0.05$ ).

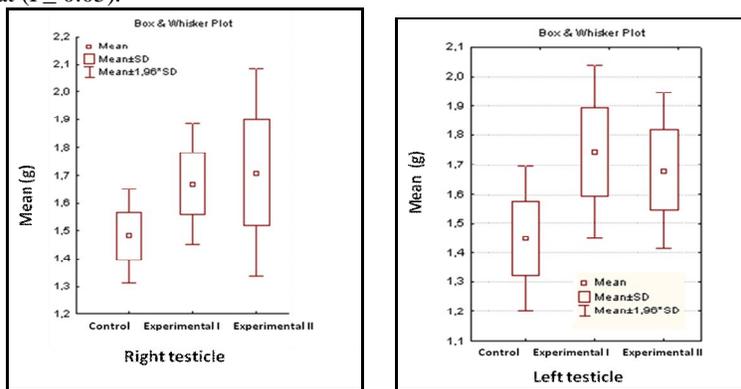


Figure 5: Testicular weights variation (right and left) in the control and treated rats. (Values are mean  $\pm$ SD).

### Serum testosterone level variation

The comparison between mean serum testosterone levels in the rats between control and experimental groups I and II are given in Table 5.

Table 5: Comparison of mean serum testosterone levels of rats.

Group	Control	Experimental group I	Experimental group II
Testosterone levels (Mean $\pm$ SD)	$0,93 \pm 0,7665$	$1,11 \pm 0,7073$	$0,32 \pm 0,2577$
P value	0,4397	0,9508	0,3506

In the control group, the value of serum testosterone varies from 0,1 to 2,25  $\text{ng.ml}^{-1}$  with an average of  $0,93 \pm 0,7665 \text{ ng.ml}^{-1}$ . In the experimental groups, the variation of values is 0,1 to 2,19  $\text{ng.ml}^{-1}$  with an average of  $1,11 \pm 0,7073 \text{ ng.ml}^{-1}$  (experimental group I) and between 0,1 to 0,8  $\text{ng.ml}^{-1}$  with an average of  $0,32 \pm 0,2577 \text{ ng.ml}^{-1}$  (experimental group II).

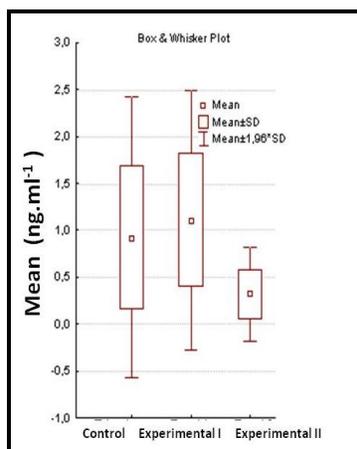


Figure 6: Serum testosterone levels variation in both control and experimental groups. (Values are expressed as mean  $\pm$  SD).

Using Post-Hoc Tukey's HSDT and D'Agostino-Pearson omnibus Tests ( $P \leq 0.05$ ), the data are statistically significant between groups (control, experimental groups I and II;  $P = 0.03$ ), while no significant ( $P > 0.05$ ) difference was observed in control assay compared to experimental groups.  $120 \text{mg.kg}^{-1}$  appeared more efficient than  $160 \text{mg.kg}^{-1}$  (Figure 6, Table 5).

## Discussion

The present study is the first to describe a survey carried out in several oases (17 oases) in southern Algeria to recognize cultivars used in herbal medicine (Figure 1). Field findings revealed 12 cultivars between 131 identified are used in traditional medicine in different date palm groves (see Figure 2, Table 2), noted that the identification of date palm cultivars is mostly based on morphological criteria of dates such as shape, size, length, width, weight, color, taste and seed (Hannachi et al., 1998; Belguedj and Tirichine, 2011; Bouguedoura et al., 2015).

Various parts of date palm seem to have a therapeutic interest as fruits, male inflorescence, pollen, palm heart, leaves and seeds. A native population inquired (131 women (41%) and 185 men (59%) aged between 17-69) underline the importance of date palm parts in medicinal practices. Nevertheless, men are more interested than women especially those aged over 40 (Figure 3).

According to the survey carried out, the consumption of date palm parts (fruits, date syrup, and palm "heart") are used in accompanying other cures.

Fresh fruits are the most food additive or supplement used in treating male and female sterility, anemia, cold, diarrhea and scorpion bites (Table 3).

The positive action of fresh dates on diarrhea was recorded by (Abdulla, 2008) due to their great amounts of insoluble fiber (57%) and soluble fiber (43%). Medical reports showed that mature dates "Tamar" are recommended for individuals suffering from type 2 diabetes by their composition of glucose and fructose (Johnson et al., 2015), also, Tamar, contain the gynecologic hormone oxytocin stimulating contractions of the uterus and cells of myoepithelial of the mammary glands (Manickavasagan et al., 2012) which have an important role in lactation (Sue Carter, 2014) and prevents prophylaxis of postpartum hemorrhage by inter-muscular injection of the first shoulder of the baby as soon as it is outside (Martinet and Houdebine, 1993; Belghiti et al., 2013). Also, a pasta of dates is used to rub the inside of the baby's mouth "tahnik", promoting strong teeth with an antimicrobial action against canker sores (Chao and Krueger, 2007) and rejuvenating and nourishing effects for the skin. Leaves and seeds are also used against some microbial species (Perveen et al., 2012), in cure gastric diseases, preventing stomach bloating and eliminate stomach gases and pollutants (Al Fadda and Abu Ayanah, 2013). Moreover, date paste mixed with rose water is very claimed to have rejuvenating and nourishing effects for the skin, as reported above (Table 3).

Notwithstanding, the date palm pollen is known to have an important role in medicinal remedies. The elderly have widely reported the traditional use of date palm pollen in treatment of anemia, male sterility and to boost fertility (Table 3). In contrast, young people less attracted by this herbal remedy, come back to this traditional uses after trying chemical medicines.

People have reported that to give prominence to the beneficial interest of pollen of date palm as food and sexual booster; it is generally advised to use it in mixture with bee's honey (men and women) or sprinkled it upon a sanitary towel during the fertile phase of menstrual cycle (women only) to improve ovulation and fertilization.

Earlier reports have summarized the importance of date palm pollen in many sexual cases. It promotes stimulating follicular hormones which could treat infertility in women and men (Elgasim et al., 1995; Marbeen et al., 2005), regulates menstrual cycle due to the presence of the hormone estrone (El-Moughy et al., 1991) and could be an effective and beneficial source in regulating the balance of sex hormones (Reshod and Al-Shagrawi, 1998). Although not yet reliably tested, pollen could help the implantation of the embryo and ensure the development of mammary glands in preparation for breastfeeding.

Nevertheless, there are no scientific reports to identify the precise cultivar or Dokkar (male date palm) chosen, ratio taken. In order to investigate the possible effect of pollen on male reproductive parameters, male adult rats have been chosen as a typical animal model for whom an oral pollen suspension (from Deglet nour highly cited) at two concentrations ( $120, 160 \text{mg.kg}^{-1}$ ) have been daily given. In parallel, a phytochemical screening of pollen powder has been done by use of color intensity (Table 1).

Our data showed that using date palm pollen suspension increases male reproductive system parameters (body weight, testicle weight and serum testosterone level). The results indicated that the consumption of pollen suspensions improved these characters at  $120 \text{mg.kg}^{-1}$  after 30 days (Figure 4.1). Recent findings indicate that  $120 \text{mg.kg}^{-1}$  of Iranian date palm pollen acts positively on sexual parameters of experimental rats (Mehraban et al., 2014).

In addition, the quantity of food (feed pellets) taken by rats enhances in each treatment with time (10, 20, 30 days) (Figure 4.2). It achieves the important value during the first month of experiment. After 30 days, it decreases for all groups (40 and 50 days). This suggests an appetizing role of date palm pollen on rats.

The phytochemical screening revealed a number of phytochemicals in date palm pollen; glycosides, starch (primary metabolites) and secondary metabolites with different amounts as saponins (important amount), phenolic acids as gallic tannins (weak amount). However, our study did not highlight the presence of flavonoids and catechin tannins.

The sweet taste of carbohydrates compounds (glycosides and starch) contained in date palm pollen might be involved in enzymatic reactions to form molecules increasing the intake of feed pellets gradually during one month of treatment. In addition, the presence of gallic tannins in date palm pollen enhances the taste and texture of food (Goldberg, 2003). Regarding the duration of treatment, 30 days appeared sufficient to enhance the body weight. This reaction could be due to the maturation of metabolism pathway of animals (Schwark, 1992). According to this report, the administration of drugs differed with the age of animals; the absorption of drugs is more efficient at the young stage than at the mature. Also, Abedi et al. (2012) have observed the effect of date palm pollen on male rats after 18 and 35 days of treatment.

Concerning the testicle weight variation, the administration of date palm pollen to rats seems to improve the weight independently of the position of the testicle in the body of rats (right or left). The two concentrations tested ( $120 \text{ mg.kg}^{-1}$  and  $160 \text{ mg.kg}^{-1}$ ) increase slightly the weight of testicles (**Figure 5**). Our results agree with those obtained by Iftikhar et al. (2011) and Bahmanpour et al. (2006) in which Iranian date palm pollen administration ( $120 \text{ mg.kg}^{-1}$ ) provides an increase in the testicular weights of male rats.

Faleh and Sawad (2006) reported that Irakian date palm pollen increase the testicle weight in rabbits. In contrast, Skaudikas et al. (2003) have noted a significant decrease of testicular weights in rats treated by other plants. On the other hand, the blood analysis of rats after daily administration of date palm pollen during 50days exposes positive effects at doses  $120 \text{ mg.kg}^{-1}$  and  $160 \text{ mg.kg}^{-1}$  on the serum testosterone level (**Figure 6**). Both concentrations tested increase the serum testosterone although  $120 \text{ mg.kg}^{-1}$  is more efficient. This enhancement might be due to increased testicle weights in male rats during 50 days of treatment. Our results are in agreement with those reported by Bahmanpour et al. (2006) and Arfat et al. (2014) underlying the efficiency of  $120 \text{ mg.kg}^{-1}$  dose in testosterone analysis. The beneficial effect of date palm pollen on male reproductive parameters could be due to its composition in secondary metabolites as saponins, gallic tannins (see **Table 4**). For instance, earlier investigation on Egyptian date palm pollen revealed the presence of saponins, proteins, carbohydrates and/or glycosides (Mahran et al. 1976). The authors mentioned that a steroidal saponin glycoside, having glucose and rhamnose as sugar moiety, included a glucoprotein with a gonadotrophic activity.

Due to the presence of saponins in its composition, the date palm pollen could be used as an herbal testosterone booster, an enhancer of libido and an adaptogenic aid for healthy and physically active men or included in formulations to promote strength (Saad et al. 2011). Saponins encourage the leydig cells of the testes to increase the testosterone production system (Anger et al., 2004). They might act in enhancement of the body natural endogenous testosterone levels by raising the levels of LH (Gakunga et al. 2014).

Our data show that date palm pollen, claimed to have an aphrodisiac potential, is able to increase the reproductive parameters of male adult rats due to the presence of carbohydrates, saponins and gallic tannins. These results might understand the high cost and no availability of pollen in many oases.

## Conclusion

An inventory of date palm cultivars used in traditional medicine in several oases of southern Algeria is established with a total 131 cultivars recognized within 12 cultivars which are involved in traditional herbal medicine use as Bamekhlouf, Deglet Nour, Feggous, Ghars, H'mira, Mech Degla, Oucht, Taddela, Takerboucht, Tanetboucht, Tazerzayt and Timdjouhart.

The field finding have recorded that the most parts used of date palm are pollen, dates (fresh fruit, pasta or syrup), leaves and seeds to treat different diseases such as male and female infertility, anemia, constipation, diarrhea, colds, cough, stomach ulcer, dizziness, cosmetic and bodycare. The elderly are more interested, especially men, by the sterility and fertility problems in relationship with body health. Indeed, the results of this study underline the importance of date palm pollen as herbal complement to boost male reproductive activity which should be studied in each oasis.

This manuscript could be an item which opens minds to another interest of the date palm in pharmaceutical research for this huge available cultural heritage.

## Authors' contribution

Study concept and management: N. B., D. C. Conducted the experiments: C. S., D. C. Collection of data: C. S. Identification of date palm cultivars: N. B., C.S Analysis and interpretation of data: C. S., D. C. Drafting of manuscript: C. S., D. C. Critical revision: D. C.

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