

# *Lepidium meyenii* Walp. improves sexual behaviour in male rats independently from its action on spontaneous locomotor activity

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## Abstract

*Lepidium meyenii* Walpers (Maca) is traditionally employed in the Andean region for its supposed properties to improve energy and fertility. The aim of this study was to evaluate the effect of acute and chronic Maca pulverised root oral administration on rat sexual behaviour. Sixty male sexually experienced rats (20 group) were daily treated for 15 days with Maca 15 mg kg<sup>-1</sup>, Maca 75 mg kg<sup>-1</sup> or saline 0.5 ml kg<sup>-1</sup>. The following sexual performance parameters were evaluated at first and last day of treatment: 1st mount (ML), 1st intromission (IL), ejaculation (EL) and postejaculatory (PEL) latencies, intercopulatory interval (ICI) and copulatory efficacy (CE). An activity cage test was carried out to evaluate if Maca-induced locomotion changes could indirectly improve rat sexual performances. It was observed that both lower and higher Maca doses acutely decreased ML, IL and ICI in a significant way ( $P < 0.05$ ), while only the 75 mg kg<sup>-1</sup> dose decreased the PEL ( $T = 29$ ,  $P < 0.05$ ). This effect seems to be the only one dose-dependent. After 15 days of treatment, both doses are able to significantly decrease ML, IL, EL and PEL, while the 75 mg kg<sup>-1</sup> dose decreased the ICI ( $T = 40$ ,  $P < 0.05$ ) too. IL, EL and PEL variations seem to be dose-related after chronic treatment. Moreover, chronic Maca treatment induced an apparently not dose-related increase in rat locomotion, during the second 10-min period of observation in the activity cage. The late in Maca-induced locomotion modification excludes that improvement of tested sexual performance parameters is related to an increase in rat aspecific activity. Thus, it was concluded that both acute and chronic Maca oral administration significantly improve sexual performance parameters in male rats. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

**Keywords:** *Lepidium meyenii*; Maca; Rat; Sex; Locomotion; Herbal remedies

## 1. Introduction

The incidence of sexual inadequacy in human males, including sexual impotence, and the concern that it causes in the affected subjects, are indirectly indicated by the great number of available treatments (drugs or combination of drugs for systemic administration, topical application or intracavernous injection) (Montorsi et al., 1995). The increasing number of men seeking help for impotence has expanded basic physiological and pharmacological research on sexual performance.

Many plants extracts are traditionally employed among different cultures in order to improve sexual performances (Gay et al., 1975; Hollister, 1975; Kirko-

rian, 1984; Nishimoto et al., 1984; Popik et al., 1995; Susset et al., 1989; De Smet, 1997a; Arletti et al., 1999); in spite of this, pharmacologists generally disparage this use, and few experimental studies have been performed in order better to define claims of efficacy (Clark et al., 1984; Taha et al., 1995; De Smet, 1997b).

*Lepidium meyenii* Walpers, well known in South America as 'Maca', is an Andean crop which it is found only in a very restricted area of central Peru in the department of Jinin and Pasco, in the agro-ecological zone above 4000 m where low temperature and strong winds limit other crops, but it can be successfully cultivated outside its current 'natural' habitat. Maca is a biennial herbaceous plant, whose subterraneous part (hypocotyl) is edible and highly valued for its nutritional value (especially proteins and minerals). The rural community is firmly convinced that eating Maca enables couples who think they are infertile to have

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children (Quiros et al., 1996; Toledo et al., 1998). Moreover, recently, athletes are finding Maca to be an excellent alternative to anabolic steroids (but the real efficacy in this field has still to be totally proved) (Grunewald and Bailey, 1993).

The aim of the present study is to determine the effect of acute and chronic oral administration of a purified extract from *L. meyenii* root on male rats sexual performances and spontaneous locomotion.

## 2. Materials and methods

### 2.1. Animals

A total of 110 Sprague–Dawley rats of either sex (90 males and 20 females) were obtained from Charles River (Calco, Como, Italy). They were housed in groups of three, males and females separately, in Plexiglas cages (40 × 25 × 15 cm), in climatized colony rooms (21 ± 1°C; 60% humidity) on a 12 h light/dark cycle, with lights off at 07:00 h. The rats were 3 months old on arrival, and weighed 240–260 g (males) and 180–200 g (females). Food in pellets (MIL, Morini, S. Polo d'Enza, Reggio nell'Emilia, Italy) and tap water were available ad libitum. Housing conditions and experimentations were in accordance with the European Community regulations on the care and use of animals for scientific purposes (CEE Council 86/609, included in the Italian D.L. 27/01/92, no. 116). The animals were accustomed to our housing conditions for at least 1 week before being used.

Females were ovariectomized under ethyl ether anesthesia and brought into estrous by the subcutaneous (s.c.) injection of 15 µg estradiol benzoate followed, 48 h later, by the s.c. injection of 500 µg progesterone. They were screened with non-experimental sexually experienced males and only those exhibiting good sexual receptivity (solicitation behaviour, and lordosis in response to mounting) and no rejection behaviour, were employed.

### 2.2. Sexual behaviour testing procedure

Sixty male rats were trained with sexually receptive females 7 times, at 5-day intervals, before the experimental test. The male rats sexual behaviour was tested during the period of darkness (between 10:00 and 14:00 h) in a sound-proof room, under a dim red light. After a 10 min adaptation period in a rectangular glass observation cage (60 × 50 × 40 cm), a stimulus female was presented to the male by dropping it gently into the cage. According to the standard procedure (Agmo, 1997), the following behavioural parameters were recorded or calculated: mount (ML) and intromission latency (IL), the time from introduction of the female

to the occurrence of the 1st mount or intromission; ejaculation latency (EL), the time from the 1st intromission to ejaculation; post-ejaculatory latency (PEL), the time from ejaculation to the subsequent intromission; mount (MF) and intromission frequencies (IF), the number of mounts and intromissions preceding ejaculation; intercopolatory interval (ICI), the average interval between successive intromissions (calculated as ejaculation latency divided by intromission frequency); copulatory efficacy (CE), a measure of intromissive success (calculated as IF divided by MF + IF). Tests were terminated immediately after the first post-ejaculatory intromission; or if intromission did not occur within 15 min from female introduction in the observation cage; or if ejaculation latency exceeded 30 min; or if PEL exceeded 15 min. All the studied rats concluded the performance in the last three pre-experimental tests, so they could be considered sexually potent.

Spontaneous motility testing procedure: in order to rule out the possibility that modifications of copulatory performance may in fact merely reflect a modification of motility, the influence of Maca extracts on locomotion was measured, in separate experiments, by means of an ultrasound apparatus (Cibertec, Barcelona, Spain) placed on the lid of the rat home cage. The activity counts were printed by an external, timer-controlled counter. After a 10 min adaptation, locomotor activity was measured for three 10 min periods, starting 30' after extract administration. Ten male rats pro treatment were tested after 12 days of oral treatment. The experiments were performed in a soundproof room.

### 2.3. Treatment

*L. meyenii* pulverised root (standardised 0.6% macamides and macaenes) was kindly offered from Santiveri (Barcelona, Spain). Maca 900 mg were diluted daily in 6 ml saline to obtain the more concentrated solution. From this solution we diluted 1 ml in saline 4 ml to obtain the less concentrated solution. With these Maca dilution we were able to administrate the daily dose in a maximal volume of 1.5 ml. Three groups of 20 male sexually experienced rats were continuously treated with *L. meyenii* pulverised root 15, 75 or saline 0.5 ml kg<sup>-1</sup> through gastric tube.

### 2.4. Statistical analysis

The data are reported as means (S.D. ± S.E.M.); the sexual behaviour parameters were analysed using Kruskal–Wallis analysis of variance followed by Mann–Whitney U test; ANOVA followed by Student–Newman–Keuls test was carried out on actimeter test results with the help of the Statistical Package for Social Science (SPSS) 6.1.2, version for Window '95. A

two-tailed 0.05 significance level was chosen for all statistical tests.

### 3. Results

#### 3.1. Sexual performances

As shown in Table 1, both lower and higher acutely administered Maca doses significantly decreased ML, IL and ICI ( $P < 0.05$ ), while only the 75 mg kg<sup>-1</sup> dose decreased the PEL ( $T = 29$ ,  $P < 0.05$ ). This effect was more evident with the higher dose (m vs. M:  $T = 25$ ,  $P < 0.05$ ). After 15 days of treatment, both doses are able to decrease ML, IL, EL and PEL in a statistically significant way (Table 2), while only the 75 mg kg<sup>-1</sup> dose reduced ICI ( $T = 40$ ,  $P < 0.05$ ). IL, EL and PEL variations after chronic treatment are significantly more important with the higher dose (m vs. M:  $T = 48$ , 48 and 49, respectively;  $P < 0.05$ ).

#### 3.2. Spontaneous motility

As reported in Fig. 1, chronic pulverised *L. meyenii* root oral administration induced an increase in rat locomotion, but only after 10 min that they were placed in the activity cage, while the most part of tested sexual

behaviour parameters normally occurs during the first 10 min of observation. In fact both lower and upper Maca dose induce a progressive increase in actimeter count ( $F = 19.41$  and  $F = 20.45$ , respectively;  $P < 0.001$ ). During the first 10 min of observation no significant differences among groups movement counts was found ( $F = 0.13$ ,  $P = 0.878$ ), while during the 2nd and the 3rd 10 min *L. meyenii* treated rats moved more often than controls ( $P < 0.001$ ).

#### 3.3. Body weight

At the end of the study no significant differences was observed about the body weight among groups.

### 4. Discussion

Clinical plant-based research has made particularly rewarding progress in many important fields like that of anticancer drugs (taxoids and comptothecins). In addition to fluid plant-derived drugs there is an enormous market for crude herbal medicines. Natural product research can often be guided by ethnopharmacological knowledge, and it can give substantial contribution to drug innovation by providing novel chemical structures and/or mechanisms of actions (Harvey, 1999).

Table 1  
Acute Maca oral administration effect on male rat sexual performance parameters

Treatment	ML	MF	IL	IF	EL	PEL	ICI	CE
0.5 ml saline kg <sup>-1</sup> (C)	200.37 ± 171.54 (60.65)	4.00 ± 3.30 (1.16)	232.25 ± 173.93 (61.49)	9.50 ± 2.67 (0.94)	540.50 ± 109.29 (38.64)	420.25 ± 97.08 (34.32)	58.51 ± 9.56 (3.38)	0.75 ± 0.17 (0.06)
Maca 15 mg kg <sup>-1</sup> (m)	43.71 ± 19.98 (7.55) <sup>a</sup>	2.50 ± 2.98 (1.05)	74.00 ± 35.88 (13.56) <sup>a</sup>	14.62 ± 8.05 (2.85)	436.29 ± 77.38 (29.25)	415.29 ± 183.98 (69.54)	28.81 ± 11.00 (4.49) <sup>a</sup>	0.84 ± 0.18 (0.07)
Maca 75 mg kg <sup>-1</sup> (M)	41.50 ± 31.19 (12.74) <sup>a</sup>	1.67 ± 2.66 (1.09)	85.33 ± 77.23 (31.53) <sup>a</sup>	17.67 ± 12.18 (4.97)	489.50 ± 215.03 (87.79)	311.70 ± 66.21 (27.03) <sup>a</sup>	33.54 ± 15.20 (6.21) <sup>a</sup>	0.88 ± 0.13 (0.05)

<sup>a</sup>  $P < 0.05$  compared with saline treated rats (Mann–Whitney-*U* test).

Table 2  
Chronic Maca oral administration effect on male rat sexual performance parameters

Treatment	ML	MF	IL	IF	EL	PEL	ICI	CE
0.5 ml saline kg <sup>-1</sup> (C)	200.12 ± 167.87 (59.35)	4.13 ± 3.31 (1.17)	232.25 ± 173.93 (61.49)	9.00 ± 1.60 (0.57)	540.62 ± 100.32 (35.47)	404.75 ± 57.33 (20.27)	61.52 ± 19.37 (6.85)	0.72 ± 0.16 (0.06)
Maca 15 mg kg <sup>-1</sup> (m)	55.25 ± 37.40 (13.22) <sup>a</sup>	5.38 ± 2.26 (0.80)	108.50 ± 59.91 (21.18) <sup>a</sup>	8.50 ± 2.88 (1.02)	369.12 ± 147.07 (52.00) <sup>a</sup>	330.37 ± 44.64 (15.78) <sup>a</sup>	50.09 ± 32.60 (11.53)	0.62 ± 0.13 (0.04)
Maca 75 mg kg <sup>-1</sup> (M)	36.37 ± 21.45 (7.58) <sup>a</sup>	4.88 ± 3.40 (1.20)	52.37 ± 26.21 (9.27) <sup>a</sup>	9.12 ± 2.95 (1.04)	253.00 ± 123.84 (43.79) <sup>a</sup>	258.87 ± 72.20 (25.53) <sup>a</sup>	29.04 ± 14.92 (5.28) <sup>a</sup>	0.67 ± 0.16 (0.05)

<sup>a</sup>  $P < 0.05$  compared with saline treated rats (two-tailed Mann–Whitney-*U* test).

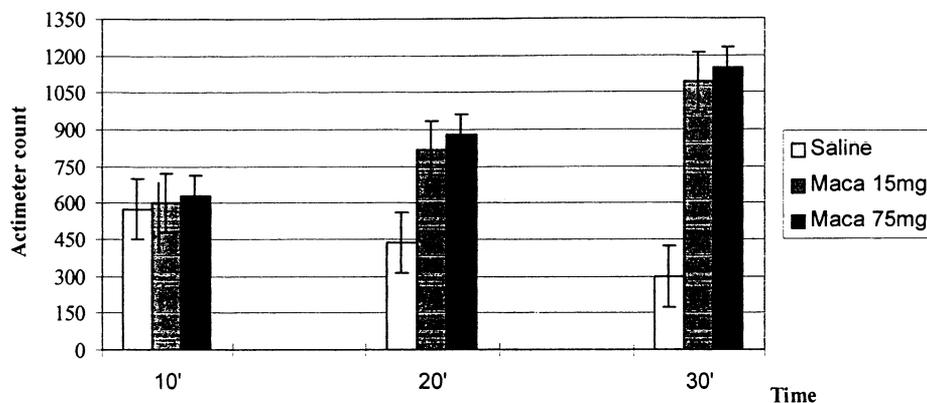


Fig. 1. Actimeter count [mean  $\pm$  S.D.] of rat movements after the 12th daily oral administration of saline or pulverised Maca root (rats received the last treatment 30 min prior to the test and were observed over a 30 min period). \*  $P < 0.05$  vs. saline treated rats (ANOVA followed by two-tailed Student–Newman–Keuls test).

Sexual incompetence, including overt sexual impotence, is a problem of increasing concern (Krane et al., 1989; NIH Consensus Development Panel on Impotence, 1993) and is not exclusive to humans. Among male rats, a variable percentage of subjects is sexually impotent, i.e. is unable to conclude with ejaculation, or even to initiate sexual intercourse with a receptive female, thus they can be considered a good model to study the sexual impotence (Agmo, 1997).

Traditionally *L. meyenii* has been used to increase energy and endurance to physical efforts, promote mental clarity, as an aphrodisiac for both men and women, for male impotence, menstrual irregularities and female hormonal imbalances including menopause and chronic fatigue syndrome. Conquistadors fed it to animals to deal with fertility problems associated with high altitudes. In 1549 the visiting Spanish Encomendero of Soto Mayor was given Maca as a tribute which he subsequently used to improve the fertility of livestock in Castille (Bermejo and Leon, 1994). In accord with anecdotal literature, experimental trials with rams eating Maca (40 g day<sup>-1</sup> for 15 days) would show increases in seminal fluid volume of 20%, in sperm motility of 40% and in sperm number of 33% (Obregon, 1998). A really recent study (Zheng et al., 2000) has shown that oral administration of a fluified lipidic extract from *L. meyenii* (standardised 0.6% macamides and macaenes) increases the number of complete intromissions and the number of sperm-positive females in normal mice and decreases the erection latency in male rats with erectile dysfunction.

In this experiments in young healthy rat, that began before the publication of Zheng's article, one has examined a complete pattern of male rat sexual behaviour, which constitutes a highly ordered sequence of motor acts that are not restricted to intromissions. The suspicion was that the most of the Maca attributed effects were correlated to the high nutritional value of the root (Dini, 1994), especially in a region where the hard geo-

graphic and climatic conditions made difficult a complete and health diet.

The present data show that orally administered Maca pulverised root improve the copulatory performance of sexually-experienced male rats: indeed the chronic treatment shortened ML, IL, EL and PEL that are considered to be inversely proportional to arousal/motivation, while IF and CE (not modified from *L. meyenii*) are considered to be indicative of performance or potency (Beach, 1956). The efficacy after acute administration in reducing ML and IL and the apparent absence of correlation between effect on spontaneous motility and sexual behaviour drive our interpretation toward the hypothesis that Maca has a pharmacological action independent from its nutritional value. Further studies with a higher number of Maca doses will give interesting data about the dose-related and no-dose related effect of *L. meyenii*. Moreover, further molecular researches are needed to evaluate which of the numerous *L. meyenii* biochemical components is responsible of the observed effect on the sexual performance parameters.

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