VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

Maca reduces blood pressure and depression, in a pilot study in postmenopausal women

This is the Accepted version of the following publication

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Short Title: Effects of Maca

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Conflict of interest/financial disclosure: None

Abstract

Objective: *Lepidium meyenii* (Maca), a herbaceous plant, has been used for centuries for its fertility enhancing and aphrodisiac properties. In an Australian study, Maca improved anxiety and depressive scores. The effects of Maca on hormones, lipids, glucose, serum cytokines, blood pressure, menopausal symptoms and general well-being in Chinese postmenopausal women were evaluated

Methods: A randomized, double-blind, placebo-controlled crossover study was conducted in 29 postmenopausal Hong Kong Chinese women. They received 3.3 g/day of Maca or placebo for 6 weeks each, in either order, over 12 weeks. At baseline, week 6 and week 12, estradiol, follicle stimulating hormone (FSH), sex hormone binding globulin (SHBG), thyroid stimulating hormone (TSH), full lipid profiles, glucose and serum cytokines, were measured. The Greene Climacteric, SF-36v2, Women's Health Questionnaire and Utian quality of life, scales were used to assess the severity of menopausal symptoms and health related quality of life.

Results: There were no differences in estradiol, FSH, TSH, SHBG, glucose, lipid profiles and serum cytokines amongst those who received Maca as compared to placebo group, however, a significant decrease in both systolic and diastolic blood pressure was apparent after Maca treatment. The Greene Climacteric Scale revealed lower scores in the areas of psychological symptoms, including anxiety and depression following Maca. SF-36v2 showed stronger improvement in general and mental health when compared to baseline, whilst the women's health questionnaire showed improvement in depression and anxiety symptoms following Maca consumption. The Utian quality of life scoring did not show any differences in all domains tested.

Conclusions: Maca does not exert hormonal or immune biological action in the small cohort of patients studies, however, it appears to reduce symptoms of depression and improve diastolic blood pressure in Chinese postmenopausal women. Although results are comparable to previous similar published studies in postmenopausal women, there might be a cultural difference among the Chinese postmenopausal women in terms of symptom reporting.

INTRODUCTION

Hormone replacement therapy (HRT) is the most effective treatment for the relief of menopause symptoms, yet many women have become reluctant to continue or commence HRT due fear of adverse risks[1]. Instead women seek alternative treatment options, particularly complementary and alternative therapies[2]. A study conducted in Australian women revealed over 50% of respondents had used complementary and alternative medicines or had visited a practitioner for the alleviation of menopausal symptoms. Further, following the release of the Women's Health Initiative Study indicating that HRT was associated with adverse health risks[3], there has been an increase in the number of dietary supplements manufactured specifically targeting menopausal women[4].

Numerous alternative therapies currently available claim to provide a wide array of benefits to menopausal women, of which some, including soy and black cohosh, have been supported by scientific evidence[4]. There are, however, numerous products for which benefit has been claimed although scientific support is lacking[2]. Maca is one example. Maca is a herbaceous biennial plant, the root of the plant *Lepidium meyenii*, is grown exclusively at high altitude (3,800-4,400 m above sea level) in the Andes region of Peru and Bolivia, where it is widely used for its putative fertility enhancing and aphrodisiac properties[5].

Maca is marketed commercially for its reported benefit in relieving menopause symptoms, although there is scant published scientific data to support any efficacy[6]. Initial research has focussed on a possible role for Maca in improving male fertility[7-14] with emerging evidence that Maca may improve sperm production and quality[7]. Although few studies have as yet examined the effect of Maca in women, data from oophorectomized rats, suggests that Maca can improve bone mass and restore trabecular network in the lumbar vertebrae, findings relevant to the high risk of osteoporosis many women face after menopause[15].

The mechanisms by which Maca may affect the male or female reproductive system remain to be elucidated. The possibility of estrogenic effects is based on the fact that Maca contains the phytoestrogen β-sitosterol[13]. Several studies, however have been unable to detect *in vivo* estrogenic effects[9,10,13], although one study has reported that Maca extracts promote proliferation of MCF-7 cells, an estrogen receptor positive human breast cancer cell line[16]. Alkaloids, isothiocynates and glucosinolates are also potential active constituents of Maca[15]. One constituent, namely the glucosinolate indoly-3-methyl (glucobrassicin) may modulate androgenic activity as it can be enzymatically hydrolysed to 3,3-diindolylmethane (DIM), known as a specific antagonist of the androgen receptor[17,18]. To our knowledge, DIM is the first example of a pure androgen receptor antagonist from plants[18].

This study seeks to examine the effect of *Lepidium Meyenii* (Maca) on hormonal profile and symptoms in Chinese (Hong Kong) postmenopausal women. In a randomized cross-over design study, serum sex hormone levels, TSH, SHBG, glucose, cytokines, and, lipid concentrations were measured in 29 post-menopausal women. Furthermore, as women often report that Maca is beneficial in alleviating menopause symptoms, changes in menopausal symptoms have also been examined in our study using the Greene Climacteric Scale, SF-36v2, the Women's Health Scale and the Utian Quality of Life Scale, all well-validated questionnaires. Although a similar methodology as described in this study has been used previously in Caucasian post-menopausal women[19], to our knowledge this is the first study examining the effects of Maca in a small cohort (pilot study) of Chinese women from Hong Kong which is a different cultural and ethnic group.

METHODS

Subjects

Thirty four healthy postmenopausal women aged between 46-59 years, who were currently experiencing symptoms of menopause, recruited by newspaper advertisement, participated in this study. All women were amenorrheic for 12 months or longer. Subjects were excluded from the study if they were currently on HRT or had taken HRT within the last 6 months; if they had a cardiac, renal, hepatic, inflammatory or psychiatric condition, or if they regularly consumed more than two standard alcoholic drinks each day. Subjects were also excluded if they currently consumed Maca supplements, or other Chinese or alternative medicine supplements for the relief of menopause symptoms. Subjects were required not to consume any dietary supplements or Chinese herbal therapies for the duration of the study.

Study Design

The study protocol was approved by the Clinical Research Ethics Committee of the Chinese University of Hong Kong and written informed consent was obtained from all participants. This was a 12 week randomized, single centre, double-blinded, placebo-controlled crossover trial. A completely randomized factorial design method was used and a researcher not involved with the study kept the study staff blinded to participants' treatment order. The sample size for this study was based on previous results published by the principal investigator[27]. Twenty-nine out of 34 women completed the trial. Fifteen women commenced

the Maca treatment first and 14 women commenced the placebo treatment first. Each subject received 3.3 g/day Maca or placebo in identical appearance and packed identically in capsulated form, for 6 weeks, in random order, with the entire study extending over a period of 12 weeks. The recommended and safe dose of Maca is up to 4 g daily. Women in this study will be consuming 3.3 g/day which is just below or equivalent to the daily recommended dose on the package of our supplier, and is based on previous human studies[8,9,19] At baseline, week 6 and week 12, venous blood samples were collected for the measurement of serum estradiol, FSH, SHBG, TSH, full lipid profiles, glucose and serum cytokines. At baseline, week 6 and week 12, women also completed the Greene Climacteric Scale (GCS) and SF-36 Version 2, quality of life questionaries to determine whether there had been any change in the severity of their physiological and psychological symptoms as well as changes in quality of life. A determination of height, body weight and blood pressure was also taken at these three time points. Maca is a root of the plant *Lepidium meyenii* cultivated high in the Andean Mountains and comes prepared to us in capsulated form (Maca Power, Healthychoices, Murwillumbah NSW, Australia), with each capsule containing 462 mg net Maca. Maca root also contains amino acids, complex carbohydrates, vitamins B1, B2, C, E and minerals. A placebo of matching color and consistency (refined white rice flour) was provided in an identical dose and packaging. Subjects were asked to consume one 3.3 g dose consisting of 7 capsules of Maca or placebo per day, 4 capsules following breakfast and 3 following dinner to ensure uniform concentration throughout the 24 hour cycle. For convenience, a daily and weekly dose was packed in plastic sachets. Participants' compliance with treatment was monitored. They were required to bring in any unused capsules at the next scheduled visit.

Measurements

Serum estradiol (E2), FSH, SHBG, TSH and lipids were analyzed by the pathology laboratory (Prince of Wales Hospital, New Territory, Hong Kong). Serum E2, FSH and TSH were analyzed using the Roche E170 immunoassay analyser with ECLIA technology (Roche Diagnostics, Indianapolis IN, USA). Mean intra-assay and inter-assay coefficient variations for the TSH assay were 1.2% and 4.0%, for the E2 assay were 1.6% and 6.4% and for the FSH assay were 1.7% and 4.4% respectively.

SHBG was determined using a solid-phase chemiluminescent immunometric assay measured on the Immulite 1000 SHBG immunoassay system (Simens Medical Solution Diagnostics Diagnostic, Los Angeles, CA, USA). Mean Intra-assay and inter-assay coefficient variations for the SHBG assay were 4.5% and 5.7% respectively.

Serum lipids were measured using calorimetric test using DP Modular Analytics with mean Intra-assay and inter-assay coefficient variations for cholesterol and HDL assays were 1.7% and 1.9% respectively, while for TG Intra-assay and inter-assay coefficient variations were 1.2% and 2.8% respectively.

Cytokines (IL-2, IL-4, IL-5, IL-10, IL-12 (p70), IL-13, GM-CSF, IFN-γ and TNF-α), were detected simultaneously in plasma samples using a multiplex pre-mixed human cytokine Th1/Th2 assay (Bio Rad, VIC Australia) according to the manufacturer's instructions. Briefly, serial dilutions of the reconstituted premixed standards were performed using standard diluent, resulting in a standard curve. Samples were also diluted 1:4 in appropriate diluent. Standards and samples were subsequently incubated in 96-well plates with anti-human antibody-coated beads provided. Removal of unbound protein was facilitated by a series of three washes using the Bio-plex vacuum manifold system and wash buffer. Biotinylated secondary and streptavidin-phycoerythrin antibodies were then sequentially bound to the beads to enable cytokine detection. Finally, the assay plates were loaded into a Bio-plex array reader to detect bound cytokines, and data analysed using the Bio-plex manager software.

Plasma glucose measurements were conducted at Victoria University's sports performance laboratory, Footscray Park, Melbourne, using a YSI 2300 STAT plus glucose analyzer (YSI). Frozen samples were thawed and vortexed to resuspend components prior to presenting each sample to the YSI sipper arm. The YSI ran an automatic calibration after every ten samples. Plasma glucose definitions were based on WHO diagnostic criteria (2006), namely Diabetes as fasting plasma glucose of ≥7.0mmol/l, and Impaired Fasting Glucose (IFG) as fasting plasma glucose of 6.1 to 6.9mmol/l.

The GCS is a well validated, non-intrusive self report questionnaire which measures the physical and psychological symptoms associated with menopause. The scale assesses psychological symptoms, with sub-scales for anxiety and depression, somatic symptoms, vasomotor symptoms, and sexual dysfunction. A total score is also calculated[20]. Test reliability for the subscales ranges from 0.83 for the vasomotor scale to 0.87 for the psychological scale[20,21].

The SF-36 Health Survey developed by Ware et al and subsequently modified (SF-36v2) by the same authors in 1996[22], is the most widely used health-related quality of life (HRQOL) measures worldwide, including Hong Kong, with over 4,000 publications[23]. The survey includes 36 items summarized into eight multi-item scales, along with 1 item of health change: physical functioning, role physical, bodily pain, general health, vitality, social

functioning, role emotional and mental health[23,24]. SF-36 has been translated and validated in more than 22 countries, including for the Chinese population in Hong Kong. Reliability estimates for physical and mental summary scores usually exceed 0.90[25]. Test reliability for the subscales is more than 0.80 (with 0.93 for mental health), except for social functioning, which has a median reliability of 0.76[25].

The Women's Health Questionnaire (WHQ) was developed in the 1980s by Myra Hunter at London University[26]. The WHQ contains 36 questions assessing 9 domains of mental and physical health, rated on a 4-point scale and was developed specifically for women during menopause transition and is available in 27 languages. WHQ measures the following subclasses, depressed mood, somatic symptoms, sleep problems, anxiety/fears, sexual behaviour, vasomotor symptoms, menstrual symptoms, memory/concentration and attractiveness. Test reliability ranges from 0.78 to 0.96 suggesting that WHQ is a highly reliable measure for mid-aged women's emotional and physical health[27].

The Utian Quality of Life (UQOL) Questionnaire is a quick 2 page (5 minute), 23 item, validated questionnaire that clinicians use, for clinical or research purposes, to understand a woman's menopause-related quality of life[28]. The UQOL Scale assesses occupational, health, emotional, and sexual quality of life and the test reliability ranges from 0.88-0.91[29].

Statistical analysis

Statistical analyses were performed using SPSS (version 16.0, SPSS Inc. Chicago). All data is expressed as the mean ± SD. Data were first assessed for normality using the Kurtosis test. Analyses of hormone levels, GCS, SF-36V2 and body weight were performed using one way repeated measures analysis of variance (ANOVA) with Tukey significance difference as a post hoc analysis account for paired data. A *P* value of < 0.05 was considered of statistical significance. One-way ANOVA analyses using treatment order as a between subjects factor indicated that there was no carryover effect in any of the measured variables.

RESULTS

Study population

Seventy-five women responded to an advertisement in a local Chinese newspaper. Following initial telephone screening 34 women were recruited, out of which 29 women

completed the trial. Five participants dropped out of the study within the first 4 weeks of commencement, 1 woman went on prolonged overseas trip, 2 became disinterested in the study, whilst 2 women dropped out due to time constrains. Data have therefore been analysed for a total of 29 women only, and the study is considered a small pilot study.

At the commencement of the study, the mean age of participants was 52.4±2.7 years (mean ± SD); had median duration of amenorrhoea 26.4±11.2 months and mean body mass index (BMI) of 23.2±3.1 kg/m^2. It is generally accepted that BMI between 18.5-25 is normal healthy weight, with 25-30 being overweight and BMI above 30 being obese, in the western world. However, there are international variations, set by the World Health Organization guidelines and in the Asian population the healthy BMI range is 18.5-22.9, with 23-24.9 being overweight and above 25 to be considered obese. Hence a proportion of the subjects were in the overweight and obese range. During the study, both body weight and BMI did not change significantly (Table 1).

Hormone profile

Anthropometric measures, serum hormone levels of estradiol, FSH, SHBG, TSH and lipid profile were measured at baseline, 6 and 12 weeks (Table 2). Spatial decrease in systolic ($P = 0.05$) and diastolic ($P = 0.01$) blood pressure were detected after 6 weeks of Maca which were statistically significant over baseline levels (Table 2). However, systolic decrease was also noted in placebo group, which as significant compared to baseline levels. No statistically significant changes in serum hormone levels or SHBG were noted ($P > 0.05$). Post hoc analysis however, show, that our study is only powered to detect a significance at ($P = 0.8$ and lambda = 0.05) a 15% increase in estradiol.

Physiological measurements

The Th1 and Th2 cytokines, the main cytokines involved in humoral and cellular immunity, were assessed to determine whether Maca intake had an effect physiologically (at the cellular level). Three cytokines (IL-5, IL-10 and IL-13) were detectable within range at the lower end, whilst 6 cytokine measures (IL-2, IL-4, IL-12, GM-CSF, IFN-γ, TNF-α) were found to be in concentrations beyond detectable range (OOR<). For analysis purposes, OOR< (undetectable) readings were included in calculations as zero values. Our results indicate that there was minimal variation in detectable cytokines between time 0, the placebo and Maca

supplemented groups and these variations were not statistically significant when applied to the Student t-test (data not shown).

The mean fasting plasma glucose for this cohort was slightly elevated in both placebo and Maca treatments when compared to values at Time 0, but this was negligible and not statistically significant (data not shown). At Time 0, 2/27 patients had impaired fasting glucose levels as defined by WHO (2006). The fasting plasma glucose for these patients decreased with placebo as well as with Maca treatment, however these changes were not statistically significant (data not shown), the study group is too small, and other factors apart from impaired glucose tolerance may have contributed to elevated plasma glucose at Time 0 in those subjects. Similar studies in a larger cohort with known impaired glucose tolerance may be warranted as to Maca's effect on plasma glucose.

Greene climacteric scale

The Greene climacteric scale (GCS) is shown in Table 3. The psychological scale indicated that Maca treatment was associated with a significant reduction in symptom scores (30% reduction from baseline values, $P < 0.05$) and after treatment with placebo (27% less than after placebo, $P < 0.05$). The psychological scale contained two subgroups, anxiety and depression. Results for the anxiety scale show a significant reduction in scores following Maca treatment compared to baseline, (30.8% reduction, $P < 0.05$) and values after treatment with placebo (27.3% decrease, $P < 0.05$). The second subscale measured depression where again a significant reduction in scores was seen following Maca in comparison to either baseline or after placebo (28.9% and 26.8%, respectively, both $P < 0.05$). In addition, somatic symptoms were significantly decreased by 27% ($P < 0.05$) compared to baseline.

The GCS also allows for a total score to be calculated. Maca decreased total scores by 22.5% in comparison to baseline ($P = 0.07$), however, a significant reduction was noted in the placebo group with a 26% reduction ($P < 0.04$). There were no significant changes seen in sexual dysfunction, vasomotor and urinary scores over the trial.

SF-36v2 scale

The mental and physical health of all participating subjects were assessed. Following Maca, patients clearly reported a significant increase in their overall health functioning, in particular, general wellbeing (10.8% increase, $P < 0.05$) and mental health (13.5% increase, $P < 0.05$) (Table 4), however, similar increases were noted following placebo. Following placebo,

social functioning (16.4% increase, $P < 0.05$), and the mental component score (13% increase, $P < 0.05$) were significantly increased to baseline. There were no statistical differences in physical functioning, role physical, body pain, vitality, role emotional and in the physical component score (Table 4).

Women's Health Questionnaire Scale

Nine domains of mental and physical health of all participating subjects were assessed. Following Maca, patients clearly reported statistically significant (34 - 36 %, $P < 0.05$) decreases in, depression and anxiety/fears. Similarly placebo showed significant decrease in anxiety score, as well as somatic symptoms and sleep problems (Table 5). No differences were reported for memory, vasomotor, sexual dysfunction, mental, and, attention states (Table 5). Interestingly, in the Greene scale and in the WHQ scale, sexual dysfunction showed non significant improvement in both Maca and placebo, even though there we've noted a significant improvement in a similar study in a Caucasian population[19].

Utian Quality of Life (UQOL) Questionnaire

The UQOL questionnaire in all 4 domains of occupational, health, emotional and sexual quality of life showed no statistical difference following Maca intake (Table 6).

DISCUSSION

Following the publication in 2002 of the first Women's Health Initiative (WHI) report[30], a dramatic decrease in HRT use resulted world-wide, mainly due to the fear of increased risk of developing breast cancer[31]. As a consequence, a large proportion of women seek alternative and complementary strategies for relief of menopausal symptoms, even though they are not as effective as HRT in treating the climacteric symptoms.

Maca has been used for centuries in the Andes to manage anaemia, infertility and hormonal balances in women. However, this is based on the long history of traditional usage and anecdotal information by local population groups. Recently, much interest on the properties of Maca has resulted in research leading to evidence of its medicinal effects in animals and in humans. In mouse and rat studies, Maca has been shown to be effective in the prevention of estrogen deficient bone loss, improves glucose tolerance, improves memory

impairment, improves sexual behaviour, invigorates spermatogenesis, exerts anti-hyperplastic effects on the prostate, and, increases litter size in female mice[14,15,32-34]. In bulls, Maca supplementation improved sperm quantity and quality whilst mating behaviours were unaffected[35]. Likewise, in human studies Maca is associated with, improved semen parameters[7], improved sexual desire in men[9] with no relationship to testosterone levels[8], helpful for erectile dysfunction[36], and improves symptoms of female sexual dysfunction[37]. Maca has also been noted to increase testosterone levels in females regularly consuming Maca[38]. We previously reported, in 14 postmenopausal women in a randomized, double-blind placebo-controlled crossover trial, that Maca had beneficial effects on psychological symptoms and measures of sexual dysfunction, but were not related to estrogen or androgen levels[27]. In other randomized clinical trials supplementation of Maca in pre- peri- and post-menopausal women showed favourable outcomes based on Kupperman Menopausal index and the Greene Climacteric Score (GCS). Furthermore, limited studies have shown evidence for Maca's effect on blood markers. Serum IL-6 levels in a cross-sectional study in 50 subjects was measured with, 27 subjects consuming Maca and 23 did not consuming Maca. IL-6 was lower in the Maca group and overall better health status scores in the SF-20 survey[39].

This study set out to determine the effect of consuming Maca for 6 weeks in Chinese postmenopausal women from Hong Kong. It is clear that there were no differences in weight, BMI, heart rate, estradiol, FSH, SHBG, TSH, HDL, LDL, triglycerides, plasma cytokines and glucose amongst the Maca and placebo groups, however, there were significant decreases in both systolic and diastolic blood pressure following Maca intake, with diastolic blood pressure being highly significant above baseline and compared to placebo group. As blood pressure is a risk factor for cardiovascular disease, this could potentially be a significant finding for lowering cardiovascular disease risk. Previous studies had also demonstrated that Maca had no effects on serum estradiol, FSH and TSH levels[9] despite other reports suggesting that Maca elevates LH and reduced FSH following Maca supplemention[6].

Maintaining optimal quality of life is a priority for women just before, during and post menopause. Measuring quality of life has traditionally been via medicines and biomedical measurements that determine the health status, however, these are not sufficient to accurately determine the overall well-being. Therefore, quality of life scales have been developed with the main objectives in mind, being, psychometric and physical properties. The Greene Climacteric Scale (GCS) measures psychological, somatic and vasomotor symptoms. The Scale is used to determine changes of symptoms in response to treatment interventions[20,21]. Herein, Chinese post menopausal women after Maca supplementation was associated with significant reduction

in psychological (anxiety and depression) and somatic symptom scores, even though similar changes were observed following placebo supplementation. Maca showed non significant decrease in sexual dysfunction, vasomotor and urinary scores.

The SF-36v2 health survey assesses functional health (mental and physical) and well being[22]. The scale determines improvement or decline in health and treatment effectiveness[22-24]. In the current study, following Maca supplementation in Chinese post menopausal women, subjects showed significant improvement in general and mental health with non-significant improvement in body pain, vitality, social functions and mental component scores. Interestingly, placebo show similar trends to Maca, with significant improvement in social functioning and mental component scores.

The Women's Health Questionnaire (WHQ), a 36 item questionnaire covering 9 areas of physical and mental status, is a well accepted international questionnaire in assessing post-menopausal symptoms. In Chinese postmenopausal women after Maca supplementation, a significant improvement in depression scores and anxiety scores were noted, with non-significant decrease in somatic, memory, vasomotor, sexual dysfunction, mental and attention scores. However, placebo showed significant improvements in somatic, anxiety and sleep scores but not in the depression score. Using the Utian Quality of Life (UQOL) score, there were no statistically significant differences in all 4 domains of occupational, health, emotional and sexual quality of life. In the recently translated but not validated Chinese UQOL demonstrated varied test reliabilities, with 0.86 (overall), 0.85 (occupational), 0.7 (health related), 0.66 (emotional) and 0.61 (sexual)[29]. The low reliability scores for emotional and sexual suggest that the reliability for these 2 domains requires further studies. Hence, the inconsistent result of UQOL in the current study compared to GCS, Sc-36v2 and WHQ surveys. It is clear from GCS, Sc-36v2 and WHQ surveys, that postmenopausal Chinese woman taking Maca supplements, resulted in significant improvement diastolic blood pressure and depression scores. This is an important outcome given that post-menopausal women are 3-times more likely to report symptoms of depression compared to pre-menopausal women. Furthermore postmenopausal women are more likely to present with cardiovascular disease as compared to men at the same age group. The studies are in accord to previous studies in males treated with Maca for 12 weeks which lowered depression scores[9], in post menopausal women treated with Maca showed improved anxiety and depressive scores[19], and demonstrated anti-depressant actions in mice[40]. It is not clear how Maca acts on reducing psychological symptoms, although flavonoids present in Maca may be responsible for these actions[40-43]. Interestingly, the reduced psychological symptoms (depression and anxiety) did

not correlate with reduced vasomotor symptoms (hot flushes), despite a strong association between the two[44,45]. However, estradiol, FSH and TSH levels are associated with vasomotor symptoms, and no changes were noted in these hormones together with no improvement of vasomotor symptoms[46]. However, sleep disorders were significantly improved. Similar findings of no beneficial effects of vasomotor symptoms in Hong Kong Chinese post menopausal women were reported with the Chinese herb Dang Gui Buxue Tang[47]. In the current study, there was improvement but not significant in sexual dysfunction (commonly reported in menopausal women), despite previous studies of Maca supplementation in post menopausal Australian women[19], in men[9] and in rodents[14]. There are suggestions that women in non-Western countries do not usually report their sexual functions and mental states, but rather freely report somatic symptoms such as headache, back pain and constipation, as opposed to women in Western or developed countries[48-50]. Various studies indicate that differences in symptom reporting are real and that both biological variation and cultural differences contribute to the menopausal transition and that more research is required to elucidate how biology and culture interact in female ageing[51,52].

CONCLUSIONS

Overall, we demonstrate that Maca does not exert an estrogenic effect in postmenopausal Hong Kong Chinese women, as indicated by the lack of change in plasma estradiol, FSH, TSH and SHBG concentrations. In addition, Maca has no effect, in immune physiology or other biological markers, in the short term, on body weight, BMI, cholesterol, HDL, LDL, triglyceride, glucose and cytokine levels. However, Maca was shown in the small cohort of patients, to be effective in reducing blood pressure and depression. Improvements were also noted for psychological, anxiety, somatic, general health, social functioning and mental health in both Maca and placebo groups. Although these results are comparable to previous similar published studies in postmenopausal women from our and other laboratories. In general, there might be cultural differences amongst the Chinese postmenopausal women in terms of symptom experiencing and reporting, as compared to the Caucasian population. In fact, it has been reported that although the incidence of hot flushes, for example, among the western women are close to 80%, only 5 - 10 % of the Asian women report troublesome vasomotor symptoms[53]. These differences may be due to both cultural and biological variations[51], however, diet may account for some of it. Although there have been a number of observational and randomized controlled trials conducted for relief of menopausal symptoms,

especially vasomotor, the clinical evidence supporting the efficacy and safety of most Complementary medicine for relief of menopausal symptoms is sparse. Differences in findings across studies of the same product may be due to less than optimal trial design, variation in products and composition of products used, inadequate dosing, the length of treatment and small population size. Furthermore, any therapy claiming to reduce hot flushes should be assessed in blinded trials as placebo effects are high[54]. Furthermore, the placebo effect In our studies were high demonstrating the person's anticipation that an intervention will help them, and these effects should be considered in alternative therapies[55]. This study gives strong evidence that a larger study and for a longer time is required to further determine the effects of Maca in postmenopausal women.

Table 1. *Body weight, kg and body mass index, [kg/m^2] ± SD during the randomized crossover design study (n=29).*

Treatment order	Baseline	6 weeks	12 weeks	Repeated measures Lambda	*P* value
Maca then placebo (n= 15)	57.7 ± 8.4 [23.2±3.3]	57.8 ± 8.3 [23.3 ±3.2]	58.1 ±8.4 [23.4 ± 3.3]	0.83 [0.77]	0.29 [0.18]
Placebo then Maca (n=14)	56.8 ± 8.5 [22.6 ± 3.2]	56.6 ±8.6 [22.5 ± 3.1]	56.5 ±8.5 [22.5 ± 3.1]	0.84 [0.88]	0.36 [0.46]

Data are the mean ± standard deviation (n=29). * Significant difference from baseline (*P* < 0.05)

TABLE 2. *Mean values of serum estradiol, FSH, TSH, SHBG and lipids at baseline, following Maca and following placebo. Data are the mean ± SD (n=29).*

	Baseline	After 6 weeks of Maca	After 6 weeks of placebo	Repeated measures Lambda	*P* value
Weight (kg)	57.3 ±8.3	57.2 ± 8.3	57.4 ± 8.4	0.96	0.54
BMI (kg/m^2)	22.9 ±3.2	22.9 ± 3.1	23.0 ± 3.2	0.96	0.55
BP Systolic	132.5 ± 18.2	125.6 ± 19.8*	126 ± 16.3*	0.80	0.05*
BP Diastolic	81.8 ± 13.1	73.8± 10.6*	77.7 ± 12.5	0.69	0.01*
Heart rate	66.5 ± 9.4	68.8 ± 7.8	65.6 ± 6.0	0.81	0.06
Estradiol (pmol/l)	46.3±8.6	48.3 ±12.5	49.5±18.7	0.93	0.40
FSH (IU/l)	77.5±19.0	79.9±23.6	75.5±19.7	0.96	0.55
SHBG (nmol/l)	47.6± 29.5	47.8 ±26.7	48.8 ±35.9	0.99	0.90
TSH (mIU/L)	1.94±1.4	2.1±1.4	2.0±1.3	0.93	0.40
Cholesterol (mmol/L)	5.4 ±0.8	5.5±0.9	5.5±0.9	0.98	0.81
HDL-c (mmol/L)	1.6±0.5	1.64±0.4	1.56±0.4	0.82	0.09
LDL-c (mmol/L)	3.2±0.8	3.3±0.8	3.3±0.9	0.91	0.32
TG (mmol/L)	1.4±0.8	1.26±0.56	1.4±0.7	0.92	0.36
Non-HDL (mmol/L)	3.9±0.8	3.9±0.9	4.1±0.9	0.96	0.64

Data are the mean ± standard deviation (n=29). BMI, body mass index; BP, blood pressure; FSH, follicular-stimulating hormone; HDL, high density lipoprotein; LDL, low density lipoprotein; SHBG, sex hormone-binding globulin; TG, triglyceride; TSH, thyroid stimulating hormone. * Significant difference from baseline (*P* < 0.05)

TABLE 3. *Mean values of scores on the Greene Climacteric Scale at baseline, following Maca and following placebo.*

	Baseline	After 6 weeks of Maca	After 6 weeks of placebo	Repeated measures Lambda	P value
Psychological	12.3±5.9	9.3±5.6*	9.0±5.5*	0.68	0.01*
Anxiety	6.7±3.5	5.1 ±3.3*	5.0±3.0 *	0.73	0.02 *
Depression	5.5 ±3.0	4.2±2.6*	4.0±3.0*	0.69	0.01*
Somatic	5.5±3.3	4.7±3.5	4.0±3.2*	0.77	0.03*
Vasomotor	2.4±1.4	2.4±1.7	2.6±1.6	0.99	0.77
Sexual Dysfunction	1.5±0.9	1.2±1.0	1.2±1.0	0.90	0.24
Urinary	2.6±1.4	2.1±1.5	2.0±1.8	0.86	0.14
Total score	22.7±9.9	17.6±10.0 (P = 0.07)	16.8±9.1*	0.78	0.04*

Data are the mean ± standard deviation (n=29). * Significant difference from baseline ($P < 0.05$)

TABLE 4. *Mean values of scores on the SF 36 V2 Scale at baseline, following Maca and following placebo.*

	Baseline	After 6 weeks of Maca	After 6 weeks of placebo	Repeated measures Lambda	P value
Physical Functioning (PF)	49.2 ±5.9	47.1 ±8.1	49.5 ±4.9	0.90	0.25
Role Physical (RP)	47.6 ±8.2	46.6 ±10.0	48.1± 8.3	0.95	0.50
Body Pain (BP)	43.1± 9.1	45.8± 8.5	45.5 ±9.1	0.88	0.19
General Health (GH)	41.7 ±10.3	46.2±7.9*	45.3 ±8.5*	0.74	0.02*
Vitality (VT)	46.5±11.7	49.7 ±9.7	50.4 ±9.9	0.91	0.26
Social Functioning (SF)	42.7 ±10.8	47.7± 9.2 (P = 0.08)	49.7 ±8.4*	0.62	0.00*
Role Emotional (RE)	42.8± 11.1	43.5 ±11.5	46.1 ±10.2	0.82	0.07
Mental Health (MH)	40.6 ±10.7	46.1± 10.8* (P = 0.03)	48.1± 9.1* (P=0.003)	0.68	0.01*
Physical Component Score (PCS)	48.0 ± 6.7	47.4 ± 6.9	47.7 ± 6.4	0.99	0.86
Mental Component Score (MCS)	40.9± 11.7	46.2 ±11.6 (P = 0.06)	48.3± 10.1*	0.66	0.00*

Data are the mean ± standard deviation (n=29). * Significant difference from baseline ($P < 0.05$)

TABLE 5. *Mean values of scores on the Women's Health Questionnaire Scale at baseline, following Maca and following placebo.*

	Baseline	After 6 weeks of Maca	After 6 weeks of placebo	Repeated measures Lambda	*P* value
Depression	0.33 ±0.25	0.21 ±0.20*	0.23± 0.20	0.78	0.04*
Somatic	0.47± 0.26	0.41± 0.26	0.31± 0.25*	0.70	0.01*
Memory	0.69 ±0.37	0.57 ±0.37	0.60± 0.33	0.87	0.16
Vasomotor	0.57± 0.32	0.55±0.43	0.52± 0.39	0.99	0.87
Anxiety	0.38 ±0.30	0.18± 0.25*	0.22 ±0.31*	0.63	0.00*
Sexual Dysfunction	0.62± 0.40	0.51 ±0.39	0.52 ±0.57	0.93	0.37
Sleep	0.53 ±0.36	0.43 ±0.40	0.34 ±0.37*	0.81	0.05*
Mental	0.24 ±0.34	0.21 ±0.27	0.24 ±0.31	0.99	0.86
Attention	0.67± 0.36	0.62 ±0.34	0.60 ±0.39	0.92	0.60

Data are the mean ± standard deviation (n=29). * Significant difference from baseline ($P < 0.05$)

TABLE 6. *Mean values of scores on the Utian Quality of Life Scale between Maca and placebo.*

	After 6 weeks of Maca	After 6 weeks of placebo	Repeated measures Lambda	*P* value
Occupation	22.0 ±5.6	21.4± 6.5	0.99	0.53
Health	21.4 ±3.2	21.4±3.3	1.00	0.97
Emotion	19.0 ±3.6	19.2± 4.4	1.00	0.86
Sexual	8.4 ±2.4	8.7 ±3.1	0.99	0.55
Total	70.8±10.2	70.8 ±13.0	1.0	0.99

Data are the mean ± standard deviation (n=29). * Significant difference from baseline ($P < 0.05$)

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