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Effects of 8 weeks administration of Korean Panax ginseng extract on the mood and cognitive performance of healthy individuals

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Abstract : *Background:* Previous research has suggested that single doses of a standardised *Panax ginseng* extract can decrease fasted blood-glucose levels and modulate cognitive performance in healthy young volunteers. The latter has generally been seen in terms of improved secondary memory performance. However, both the cognitive effects of chronic administration of ginseng and the potential modulation of working memory have received comparatively little research attention.
Aims: The current double-blind, placebo-controlled, balanced cross-over study investigated the effects of 8-weeks administration of Korean ginseng extract (200 mg) on cognitive performance, gluco-regulatory parameters and ratings of subjective mood and 'quality of life'.
Methods: Eighteen healthy young participants were assessed pre-dose and 3 hours post-dose on the mornings of Day 1, Day 29 and Day 57 of 8 week treatment regimens of both placebo and ginseng. A four-week placebo wash-out separated the treatment phases. Each assessment included the Cognitive Drug Research battery, computerised working memory tasks, and Bond-Lader mood scales. The WHO Quality of Life scale (WHOQOL-BREF) was completed once per visit. Gluco-regulatory parameters were assessed with assays of blood glucose, insulin and HbA1c.
Results: Data from the 16 participants that completed the study showed that there were no significant, acute treatment related differences on Day 1 of treatment, or in gluco-regulatory parameters throughout the study. However, time related performance improvements were evident following chronic administration of ginseng on the '3-Back' and 'Corsi-block' computerised working memory tasks. Ginseng was also associated with an improved score on the 'social relations' subscale of the WHOQOL-100, and a significant shift on the 'calm' factor of the Bond-Lader mood scales (from calm/relaxed towards excited/tense).
Conclusion: The results of the current study suggest that Korean ginseng extract can modulate working memory performance and subjective ratings of 'quality of life' and mood. Replication with a larger sample size may further elucidate the actions of this product.

Key words : Korean Red Ginseng, Human, memory performance, benefits on quality of life

INTRODUCTION

A large body of research has developed investigating the effects of members of the plant genus Panax (ginseng). The majority of this work has involved *in vitro, ex vivo* and *in vivo* experimentation that has demonstrated a plethora of cellular and physiological effects and enhancement of a number of behavioural parameters in animals.[1] However, in humans the evidence of beneficial behavioural effects following chronic administration of ginseng is somewhat equivocal. Bahrke and Morgan[2,3] note that, whilst there is a body of work attesting to ginseng's efficacy in improving human physical performance, the methodology of many studies makes any firm conclusions impossible.

A number of studies have, however, demonstrated improvements in subjective 'well being' or 'quality of life' attributable to ginseng taken alone[4-7] or in combination with vitamins[8,9] over a period of time. However, it should be noted that a number of studies have failed to find this effect.[10-13]

Over the past few years a number of double-blind, counterbalanced, placebo-controlled, experiments conducted in our own laboratories, using the Cognitive Drug Research (CDR) computerised assessment battery, have

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shown that single doses of *Panax ginseng* extract G115 can reliably improve secondary (but not working) memory performance, either in terms of accuracy[14, 15] or speed of performance.[16] Similar mnemonic accuracy effects have also been observed following single doses of a combination of *Panax ginseng* and *Ginkgo biloba* .[17, 15]

Further acute dose studies have also demonstrated reduced latency of the P300 component of auditory evoked potentials and a stronger pattern of topographic EEG effects following *Panax ginseng* than those elicited by *Ginkgo biloba*.[18] Most recently, reduced fasted blood glucose levels following *Panax ginseng* and concomitant improvements in performance during extended execution of a 'mental demand' battery in healthy young participants have been demonstrated[19], with these gluco-regulatory effects confirmed in a further study.[20]

Whilst these results suggest robust psychoactive and gluco-regulatory effects following single doses they tell us little about the effects of chronic administration of *Panax ginseng* on cognitive performance or physiological parameters. Furthermore, whilst the CDR battery is a sensitive instrument for drug discovery trials and includes several secondary memory tasks, its working memory component is less than optimal. On the basis of the currently available data, the possibility cannot be excluded that the measures thus far employed have simply failed to measure existing working memory effects. The current study therefore investigated the effects of acute and chronic administration of Korean *Panax ginseng* extract on a range of cognitive tasks, including those assessing both secondary and working memory, self-ratings of mood and psychological well-being, and gluco-regulatory parameters in healthy participants.

METHODS AND MATERIALS

STUDY DESIGN

The study employed a randomised, double-blind, placebo-controlled, counterbalanced crossover design. Participants were randomly assigned to cohorts receiving either ginseng or placebo during the first 8 weeks of the study and the opposite treatment in the last 8 weeks of the study. Treatment periods were separated by a 4 week placebo wash-out period. The timelines of the study are shown in Fig. 1.

PARTICIPANTS

Thirteen female and 5 male (mean age 38.31; sd 10.3) volunteers participated in the study. Two participants failed to complete the study, leaving 16 evaluable sets of data. Prior to participation each participant gave informed consent and completed a medical health questionnaire. All participants reported that they were in good health and were not taking any illicit social drugs. Additionally, they were free from 'over the-counter' or prescribed medications, with the exception, for some female volunteers, of the contraceptive pill. Heavy smokers (> 5 cigarettes/day) were excluded from the study. All participants fasted overnight and were alcohol and caffeine free for 12 hours prior to all assessment sessions. They also abstained from psychoactive products during the testing day. The study was approved by the Northumbria University Division of

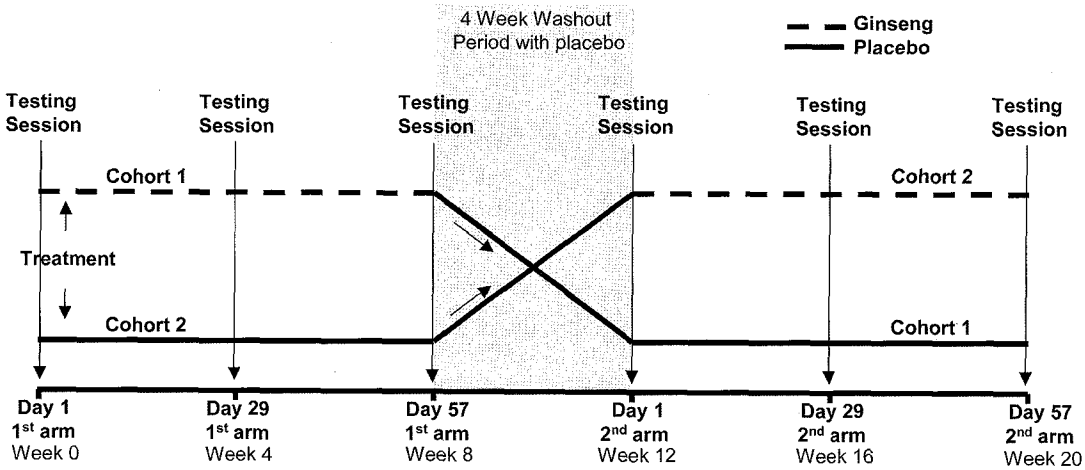

Fig. 1. Time lines of the study. Participants received either placebo or ginseng during the first arm of the study (weeks 0 to 8), and the opposite treatment in the second arm (weeks 12 to 20). All participants received placebo during the washout period (beginning of week 9 to end of week 12). Testing days took place on days 1, 29, and 57 of each arm.

Psychology Ethics committee and conducted in accordance with the Declaration of Helsinki. Treatment order was randomly counterbalanced.

TREATMENTS

Each day of the study participants were required to consume two apparently identical capsules, containing either placebo or a total of 200 mg of Korean *Panax ginseng* extract. Each participant took each treatment for 8 weeks, with a 4 week placebo wash-out period between treatment arms. On testing days participants consumed their day's treatment in the laboratory.

On each testing day of the study participants were required to surrender any unconsumed capsules and were issued with a new supply of capsules to last until the next testing day.

All treatments were packaged and coded by a disinterested third party, who retained the emergency code break for use in the event of any serious adverse events.

PROCEDURE

Testing took place amongst a suite of testing facilities within the Human Cognitive Neuroscience Unit. Testing sessions for each individual commenced at 8.20 am and took place every four weeks on the same day of the week.

Practice day

Prior to commencement of the study participants attended a practice study day during which the procedure was identical to the other six study days, with the exception that no treatment was offered, nor blood samples taken. The data from this practice day was not analysed other than to ensure that each participant's performance lay within established norms for this population. Following completion of the practice day participants were randomly allocated to the counterbalanced treatment groups.

The study day

Prior to each study day participants refrained from eating food and caffeinated products from midnight on the night before the study. On arrival at the laboratory they completed the WHOQOL-BREF, and then gave a finger prick blood sample followed immediately by a venous blood sample. Participants then completed a baseline cognitive/mood assessment followed by the ingestion of their day's treatment. Participants were then provided with a light standard breakfast. Three hours post-dose a second finger prick blood sample was obtained and then participants completed a further cognitive/mood assessment.

Running order of each study day is shown in figure 2.

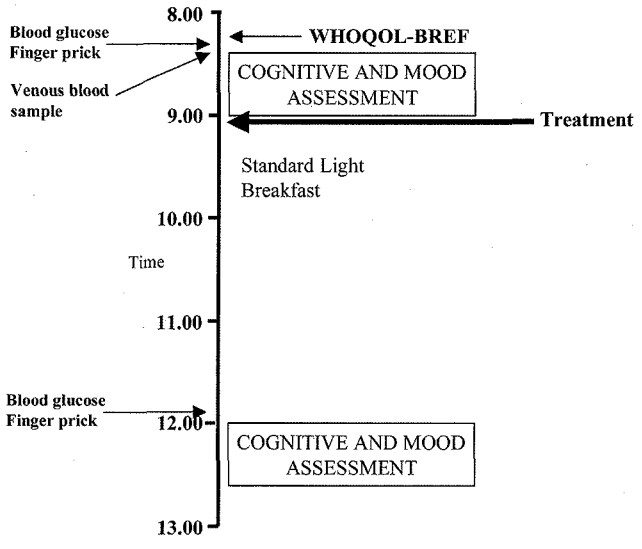

Fig. 2. Running order of each study day (day 1, 29 and 57 of both the 1st and 2nd arms).

MATERIALS

The cognitive and mood assessment comprised:

Cognitive Drug Research (CDR) computerised assessment battery

This battery is approved globally for use in clinical trials, and has been used in more than 500 European and North American drug trials. It has been shown to be sensitive to acute cognitive improvements[21,22] as well as impairments with a wide variety of substances.[23,24]

A tailored version of the CDR battery was used that has previously been found to be sensitive to modulation of cognitive function as a consequence of acute[25,14,17,15,26,16] and chronic[27,28] ingestion of a number of herbal products. The selection of computer controlled tasks from the system was administered with parallel forms of the tests being presented at each testing session. Presentation was via desktop computers. With the exception of written word recall tests, all responses were recorded via a two-button (YES/NO) response box with both accuracy and speed data being collected.

The tasks making up this 20 minute version of the battery were: *Immediate word recall (followed by picture presentation); Simple reaction time; Digit vigilance; Choice reaction time; Spatial memory; Numeric working memory (Sternberg); Delayed word recall; Delayed word recognition; Delayed picture recognition* (for task details see publications above).

The outcome measures from the battery comprised the

five cognitive factors (Secondary Memory, Working Memory; Speed of Memory; Speed of Attention; Quality of Attention) that can be derived from the single task outcomes by factor analysis.[28]

Working Memory Tasks

Corsi Block Tapping task

A computerised version of this classic nonverbal short-term memory task was utilised. In this task nine identical blue squares appear on screen in non-overlapping random positions. A set number of blocks change colour in sequence, with the participant repeating the sequence by clicking on the blocks using the mouse and cursor. The task is repeated five times at each level of difficulty. The sequence span increases from 5 upwards, until the participant can no longer correctly recall the sequence, resulting in a span measure of nonverbal working memory, plus speed of performance data.

3-back task

In this computerised working memory task participants are presented with a continuous string of letters (upper and lower case - inter-stimulus interval 2.5 secs - task running time 2 minutes), and indicate (yes/no) whether this was the same letter that appeared three letters before. The task is scored for correct, false alarms and reaction times.

Alphabetic working memory

In this more demanding version of the 'Sternberg' numeric working memory task participants are presented with 5 letters of the alphabet to memorise. A string of 30 single letters (15 targets, 15 distractors) are then presented to the participant, who responds yes/no as to whether the letter was one of those presented at the beginning of the task. The task comprises three separate trials, and is scored for number correct, false alarms, and reaction times.

Subjective mood and 'quality of life' measures

Bond-Lader Mood scales[29]

These scales were originally designed for assessing the mood effects of anxiolytics[29] and have been subsequently utilised in numerous pharmacological, psychopharmacological and medical trials. As with other mood visual analogue scales high reliability and validity have been demonstrated.[30] The scales consist of 16 100mm visual analog scales anchored by antonyms (eg Alert-Drowsy, Lethargic-Energetic, etc). The scores are combined as recommended by the authors to form three mood factors: 'alert', 'calm', and 'content'.

World Health Organisation Quality of Life questionnaire – BREF: (WHOQOL-BREF)

The WHOQOL –BREF is an abbreviated version of the WHOQOL –100. The WHOQOL –BREF contains a total of 26 questions, one item from each of the 24 facets contained in the WHOQOL-100 and two items from the overall quality of life and general health facet. The 26 questions are factored down into one of four domain factors; physical health, psychological health, social relationships, environment.[31]

Blood glucose parameters

Blood glucose levels were monitored, via capillary finger prick, using a Reflotron Plus diagnostic machine and Reflotron test sticks (Roche Diagnostics, Germany). The reliability of the test has been confirmed through direct comparisons with the hexokinase method (Roche Diagnostic Limited).

Blood insulin levels in venous blood were established using a solid phase enzyme amplified sensitivity immunoassay (BioSource INS-EASIA) performed on microtiterplates. The assay uses monoclonal antibodies directed against distinct epitopes of insulin.

HbA1c levels in venous blood were established using a Tosoh G7 HbA1c analyser. This system uses a cation exchange column to separate haemoglobin components by different ionic charge. The various components of haemoglobin, including A1c, are separated into 6 fractions and assayed.

STATISTICS

All data were analysed using the Minitab statistical package version 13.1 as 'Change from pre-dose Day 1 baseline' scores.

Acute effects:

Change from baseline (Day 1 pre-dose) data obtained from the 3hr post-dose testing session on Day 1 was analysed by one-way (placebo v ginseng) repeated measures analysis of variance (ANOVA) to reveal any purely acute effects.

Chronic and superimposed effects:

Change from baseline (Day 1 pre-dose) data obtained from the pre-dose and post-dose assessments on Day 29 and Day 57 was analysed by three way (treatment x day x pre-post dose) repeated measures ANOVA to reveal any effects of chronic and super-imposed chronic/acute administration of Korean ginseng.

HbA1c, Insulin, WHOQOL-BREF

For these measures only pre-dose data was obtained.

Analysis of chronic effects was therefore by two-way (treatment x day) repeated measures ANOVA.

Planned comparisons

On those measures that yielded a significant main effect or an interaction effect with treatment, planned comparisons were made between placebo and the active treatment at each assessment on both Day 29 and Day 57 utilising t tests with MSError as an error term (Keppel, 1991) to reveal any underlying patterns of effects. To ensure the overall protection level, comparisons were only conducted on those outcome measures that reached statistical significance on the initial ANOVA. Additionally, all comparisons were strictly pre-planned and all testing was two-tailed.

RESULTS

There were no purely acute effects (Day 1) of treatment on any measure within the study.

COGNITIVE MEASURES

Cognitive Drug Research battery

There were no significant treatment related effects on the cognitive factors derived from the CDR battery tasks.

Working Memory tasks

3-Back Task

Whilst accuracy of performance was unaffected, analysis of variance revealed a significant interaction (treatment x week x assessment) on the speed of carrying out the N-Back Task [F (1,15)=9.23, p=0.008]. Planned comparisons (see Figure 3.) revealed that the ginseng condition outperformed placebo at the post-dose assessment on Day 29 [t (15)=2.892, P=0.011] and on both assessments on Day 57 (pre-dose [t (15)=5.404, P=0.0001] and post-dose [t(15)=2.403, P=0.030] respectively).

Corsi Block task

ANOVA revealed a significant interaction (treatment x week x assessment) on digit span as assessed by the Corsi Block task [F (1,15)=5.78, p=0.03]. Planned comparisons (see Fig. 4.) revealed that the ginseng condition outperformed placebo at the pre-dose assessment on Day 57 [t (15)=2.98, P=0.009] with a trend towards the same effect at the post-dose session on Day 29 [t (15)=1.82, P=0.088].

MOOD AND QUALITY OF LIFE MEASURES

Bond-Lader visual analogue mood scales

Analysis also showed a significant main effect [F (1,15) =5.05, P=0.04] of ginseng on the 'calm' factor from the Bond-Lader mood scales representing a shift from the 'calm' and 'relaxed' poles of the two contributing visual analogue scales, towards the 'tense' and 'excited' poles respectively across chronic assessments (Fig. 5 top).

Planned comparisons comparing treatment to placebo at each testing session revealed that Korean ginseng led to modulation of this parameter on Day 29 both pre-dose [t (15)=2.60, P=0.020] and post-dose [t (15)=3.667, P= 0.0023] and Day 57 pre-dose [t (15)=3.30, P=0.005] and post-dose [t (15)=5.64, P=0.035] (Fig. 5. bottom).

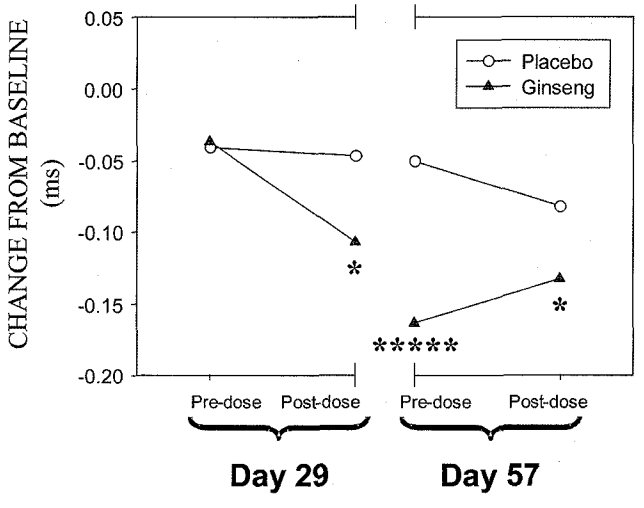

Fig. 3. Speed of carrying out the 3-Back task following 4 and 8 weeks of treatment with Korean ginseng and placebo. Downward direction equates to greater speed. (*=p< 0.05, *****=p<0.0005 on planned comparisons between treatments at each assessment).

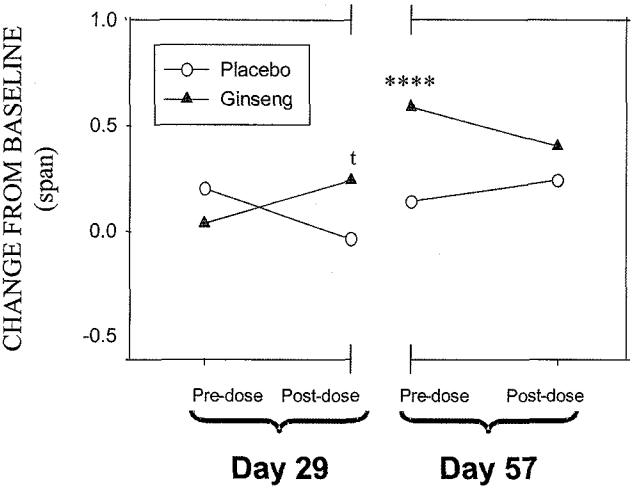

Fig. 4. Change from baseline in spatial working memory span as assessed by the Corsi Block task at each assessment (*=p<0.05, ****=p<0.005 on planned comparisons between treatments at each assessment).

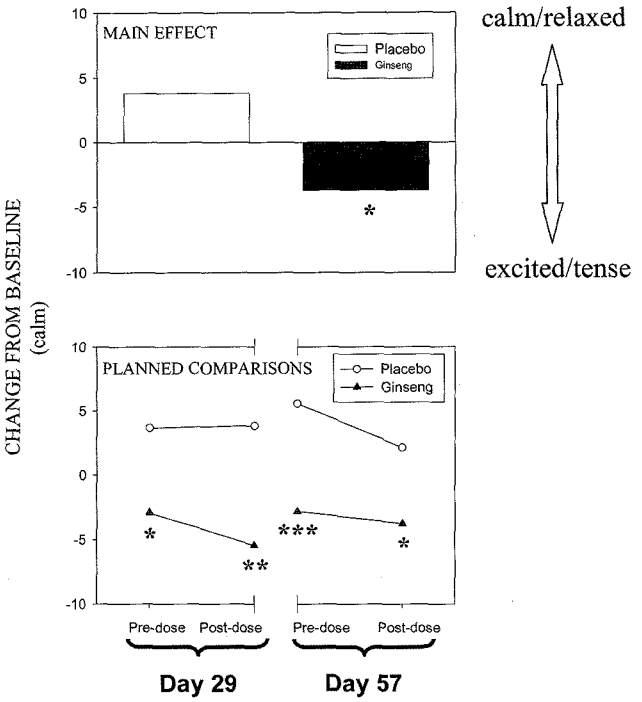

Fig. 5. The main effect (top) and planned comparisons at each assessment (bottom) of the effect of Korean ginseng on the 'calm' factor of the Bond-Lader scales. (*=p<0.05, **=p<0.01, ***=p<0.005 on planned comparisons between treatments at each assessment)

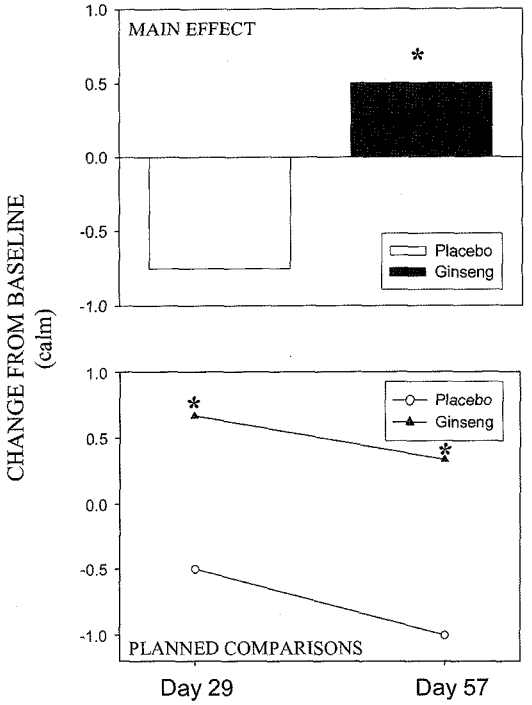

Fig. 6. Main effect (top) and planned comparisons across both days (bottom) showing the positive effect of Korean ginseng on the 'social relations' scale of the WHO Quality of Life (WHOQOL-BREF) scale. (*=p<0.05)

World Health Organisation Quality of Life questionnaire (WHOQOL-BREF)

The ANOVA revealed a main effect of treatment on the 'social relations' scale from the WHOQOL-BREF [F (1,15)=5.95, P=0.028] (Fig. 6. top) representing a ginseng related improvement across chronic assessments.

Planned comparisons comparing treatment to placebo on each day (this measure was taken once per day) also revealed that Korean ginseng led to significantly improved self-report ratings on both Day 29 [t (15)=2.52, P=0.023] and Day 57 as compared to placebo [t (15)= 2.88, P=0.011] (Figure 6. bottom).

GLUCO-REGULATORY PARAMETERS

There were no significant differences seen between treatments on any of the gluco-regulatory parameters (Blood glucose, insulin, HbA1c).

DISCUSSION

The results of the current study demonstrate that chronic administration of 200 mg of Korean ginseng extract per day to healthy participants can have a positive effect both in terms of aspects of cognitive performance and self-ratings of mood and subjective 'quality of life'. No effect of the treatment was evident either on the first (acute) day of treatment, or on the gluco-regulatory parameters under investigation.

In the case of cognitive performance, positive modulation was seen here on two out of three tasks that had been specifically included to assess working memory performance. Improvements were seen both in the speed of performing the '3-Back' working memory task, and in spatial working memory span, as assessed by the computerised 'Corsi Block' task. Previous research has demonstrated improved secondary memory, rather than working memory performance following a single dose of *Panax ginseng* extract utilising the CDR battery[14,15,26], but it should be born in mind that this battery lacks a coherent assessment of working memory. In this case performance of the tasks within the CDR battery was not significantly modulated by the treatment, even following a single dose, and this may be due to differential effects of the extracts employed in this and previous studies, or alternatively to simple methodological differences (see below).

Table 1. Baseline (Day 1 pre-dose) and change from baseline data (plus standard errors) for all assessments on all measures within the study.

		Baseline		Acute effects		Chronic / superimposed effects							
		Day 1 post-dose	se	Day 1 post-dose	se	Day 29 pre-dose	se	Day 29 post-dose	se	Day 57 pre-dose	se	Day 57 post-dose	se
CDR computerised battery													
Quality of memory (% X 6)	placebo	395.03	*10.40*	-27.100	*11.740*	16.545	*9.869*	-7.606	*16.012*	12.023	*18.804*	-18.413	13.603
	200mg	406.51	*15.86*	-47.29	*12.502*	-18.610	*15.960*	-39.957	*13.843*	-15.658	*17.179*	-30.608	10.104
Secondary memory (% X 4)	placebo	211.041	*8.454*	-20.63	*10.53*	13.229	*8.690*	-7.710	*13.723*	7.604	*15.451*	-12.397	10.108
	200mg	217.291	*15.050*	-42.39	*12.91*	-13.750	*13.415*	-33.437	*12.927*	-13.332	*16.780*	-19.478	11.514
Working memory (% X 2)	placebo	183.986	*4.375*	-6.48	*6.93*	3.318	*3.131*	0.104	*3.281*	4.419	*5.069*	-6.017	5.730
	200mg	189.221	*2.432*	-4.90	*3.15*	-4.861	*3.896*	-6.520	*3.919*	-2.326	*1.894*	-11.130	6.135
Speed of attention (summed ms)	placebo	1134.216	*24.665*	14.08	*12.12*	29.983	*21.514*	19.613	*19.628*	7.085	*20.029*	35.072	27.603
	200mg	1152.153	*29.746*	-0.23	*16.57*	5.442	*16.700*	-4.197	*21.123*	66.846	*45.737*	19.263	16.749
Speed of memory (summed ms)	placebo	2969.053	*137.018*	-55.94	*58.80*	-12.104	*65.326*	-78.410	*85.725*	-42.086	*59.807*	-59.907	74.178
	200mg	2931.286	*160.755*	54.62	*38.10*	45.971	*73.573*	1.352	*76.002*	56.692	*105.175*	6.389	86.489
Accuracy of attention (%)	placebo	364.167	*1.973*	-1.67	*2.27*	-0.458	*2.340*	-3.041	*2.398*	-0.396	*2.799*	-1.104	2.448
	200mg	364.501	*2.640*	-2.04	*2.92*	2.396	*2.543*	-5.125	*3.011*	-0.146	*3.170*	0.583	3.115
Corsi Block													
Span	placebo	5.238	*0.210*	0.18	*0.23*	0.200	*0.224*	-0.038	*0.268*	0.138	*0.140*	0.238	0.193
	200mg	4.925	*0.168*	0.33	*0.26*	0.038	*0.245*	0.238	*0.240*	0.588	*0.190*	0.400	0.221
Alphebetic Working Memory													
Targets	placebo	13.354	*0.271*	-0.21	*0.22*	-0.021	*0.259*	0.438	*0.327*	0.500	*0.265*	0.125	0.235
	200mg	13.646	*0.244*	0.21	*0.28*	-0.229	*0.320*	-0.104	*0.282*	-0.438	*0.310*	-0.042	0.349
Reaction time (ms)	placebo	0.740	*0.041*	-0.02	*0.02*	-0.017	*0.023*	-0.032	*0.025*	0.025	*0.035*	-0.049	0.030
	200mg	0.714	*0.033*	-0.01	*0.02*	0.002	*0.022*	0.004	*0.028*	0.001	*0.028*	-0.004	0.021
N Back													
Targets	placebo	10.313	*0.778*	0.69	*0.60*	-0.188	*0.807*	-0.625	*0.752*	0.625	*0.682*	0.500	0.577
	200mg	10.000	*0.612*	0.75	*0.50*	0.563	*0.773*	0.313	*0.568*	0.000	*0.524*	-0.125	0.584
Reaction time (ms)	placebo	0.832	*0.047*	-0.09	*0.04*	-0.041	*0.045*	-0.047	*0.031*	-0.050	*0.048*	-0.082	0.046
	200mg	0.868	*0.067*	-0.05	*0.05*	-0.037	*0.031*	-0.107	*0.036*	-0.163	*0.048*	-0.133	0.049

Table 1. Continued.

		Baseline		Acute effects		Chronic / superimposed effects							
		Day 1 pre-dose	se	Day 1 post-dose	se	Day 29 pre-dose	se	Day 29 post-dose	se	Day 57 pre-dose	se	Day 57 post-dose	se
Bond-lader mood scales													
Alert	placebo	52.975	*3.513*	1.74	*3.08*	5.719	*2.775*	6.544	*4.378*	4.838	*4.219*	3.056	*5.234*
	200mg	52.575	*4.219*	-1.90	*2.37*	1.475	*3.847*	1.594	*3.954*	4.375	*3.300*	6.288	*3.534*
Content	placebo	66.363	*3.838*	0.38	*1.12*	1.075	*3.352*	2.175	*3.699*	3.838	*2.779*	2.425	*3.134*
	200mg	65.750	*3.602*	-0.38	*1.37*	1.613	*3.230*	1.588	*2.359*	1.663	*2.525*	2.000	*3.267*
Calm	placebo	63.625	*4.191*	-0.13	*2.30*	3.688	*2.741*	3.844	*2.105*	5.563	*2.731*	2.156	*3.335*
	200mg	70.375	*3.538*	-2.34	*2.18*	-2.906	*2.282*	-5.469	*2.237*	-2.813	*2.825*	-3.750	*2.884*
WHOQOL-BREF													
Physical Health	placebo	12.57	*0.35*			0.035	*0.236*					0.000	*0.261*
	200mg	12.43	*0.46*			-0.071	*0.245*					0.071	*0.329*
Psychological Health	placebo	13.67	*0.48*			-0.125	*0.204*					-0.083	*0.321*
	200mg	13.29	*0.49*			0.250	*0.296*					0.375	*0.251*
Social relations	placebo	15.42	*0.68*			-0.500	*0.363*					-1.000	*0.463*
	200mg	14.50	*0.82*			0.667	*0.512*					0.333	*0.375*
Enviromental	placebo	15.41	*0.50*			-0.344	*0.335*					-0.156	*0.397*
	200mg	15.16	*0.58*			0.156	*0.329*					-0.375	*0.212*
Insulin	placebo	13.98	*1.00*			0.584	*1.381*					-0.863	*0.754*
	200mg	13.99	*1.32*			-0.875	*1.427*					-0.428	*1.936*
HbA1c	placebo	5.46	*0.09*			-0.183	*0.066*					-0.325	*0.059*
	200mg	5.48	*0.10*			-0.100	*0.056*					-0.175	*0.056*
Finger prick blood glucose levels	placebo	5.648	*0.126*	-0.162	*0.199*	-0.254	*0.145*	-0.489	*0.218*	-0.292	*0.166*	-0.346	*0.200*
	200mg	5.434	*0.148*	-0.171	*0.147*	0.092	*0.176*	-0.326	*0.304*	0.114	*0.195*	-0.024	*0.256*

Regarding the self-report measures, consistent modulation was evident both on the WHO Quality of Life scale, and on the 'calm' factor generated from the Bond-Lader scales. In the case of the former, improvement was seen on the 'social relations' sub-scale, which assesses subjective ratings of both personal relationships and sexual activity. It is interesting to note this potential concordance with ginseng's reputed aphrodisiac properties. This finding is also broadly in line with previous studies that have demonstrated a positive effect of ginseng on ratings of 'quality of life' or 'well-being'.[9, 4-8)]

With regards the Bond-Lader scales, scores on the 'calm' factor were modulated. This factor comprises the scores from two visual analogue scales. In this case the shift was away from the 'calm' and 'relaxed' poles towards the 'tense' and 'excited' poles of the respective scales. Whilst movement towards 'calm' and 'relaxed' is often seen following mildly sedative natural treatments the shift here could be seen as being in keeping with a treatment that increases energy and vigour.

The above pattern of results could be described as being relatively modest, but this may well be due to methodological considerations. In particular, the results may have been clearer and evident across further parameters if the sample size had been larger than the 18 (with 16 evaluable sets of data) employed here. However, given the nature of the study, and the scope of the tests employed, the resources available precluded using a larger cohort. Similarly, a within subjects design was employed here. This is a relatively economical design in terms of experimental power, but it does allow the possibility that the effects of the treatment in the first arm can carry across the wash-out period (4 weeks in this instance) into the second arm of the study. It would therefore be of interest to replicate this study with a much larger sample size and a parallel groups design.

In conclusion, chronic administration of Korean ginseng was found to modulate working memory performance and ratings of 'mood' and 'quality of life', but with no appreciable concomitant effect on gluco-regulatory parameters. These interesting preliminary findings would benefit from being replicated in a considerably larger sample utilising a parallel-groups design.

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