WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 7.523
Volume 6, Issue 6, 1452-1468. Research Article ISSN 2277–7105

ASSESS THE EFFICACY OF STANDARDIZED GREEN COFFEE BEAN EXTRACT (GCB-70) IN OVERWEIGHT HUMAN SUBJECTS

N. Verma[1], M. Mittal[2], V. Awasthi[3], Kiran Tiwari[4] and G. Lamgora[4]*

[1]Professor, Department of Physiology, King George's Medical University Lucknow India.

[2]Associate Professor, Department of Endocrinology King George's Medical University, Lucknow, India.

[3]Research Assistant, Department of Physiology, King George Medical University, Lucknow, India.

[4]R & D, Chemical Resources, Panchkula, Haryana, India.

Article Received on
23 April 2017,

Revised on 12 May 2017,
Accepted on 02 June 2017

DOI: 10.20959/wjpr20176-8652

***Corresponding Author'**
G. Lamgora
R & D, Chemical Resources, Panchkula, Haryana, India.

ABSTRACT

Background: Obesity and overweight are medical conditions which are characterized in the obese individuals by body mass index (BMI) of more than 30 kg/m^2 and 25 kg/m^2, respectively. Several environmental, nutritional & hormonal factors imbalances the energy between calories consumed and calories expended, which develops obesity and overweight. GCB-70, which is a green coffee bean extract, contains phenolic compounds such as chlorogenic acid which contributes towards the anti-obesity property of it. Chlorogenic acid in GCB-70 is believed to reduce the generation of new fat cells along with the enhancement of thermogenesis *i.e.* the natural burning of fat for energy in the body. **Methodology:** This was an open-labeled, single centric & single armed clinical study conducted in 100 overweight or obese subjects to evaluate the anti-obesity effect of GCB-70. GCB-70 with 70% chlorogenic acid of was consumed orally as 500mg capsule by both male & female patients as BD dosage for 12 weeks. **Results:** GCB-70 was proved to be effective and safe in both the male & female obese individuals. There was 6% significant decrease in the mean body weight of the enrolled subjects till the completion of the treatment as compared to the baseline levels (p-value: 0.000**). BMI was also observed to be significantly decreased up to 5.65% in the 96% study population (p-value: 0.000**). Waist circumference of the male subjects was reduced up to 6.77% and of female subjects up to 6.62% on completion of treatment. The plasma leptin levels were also decreased significantly

up to 13.59% till the completion of treatment. There were no abnormal alterations in the biochemical parameters (ALT, AST and ALP) & hematological parameters (Hb, TLC and DLC) in the enrolled subjects on completion of the treatment. **Conclusion:** It can be concluded from this clinical study that GCB-70 is completely effective and safe for the clinical management of obesity and its complications in the obese subjects.

INTRODUCTION

Non-communicable diseases have emerged as a major public health threat for all levels of the society worldwide. They accounted for about 38 million deaths in 2012 and this number is expected to rise to 52 million by 2030. One of those non-communicable diseases contributing in this much of prevalence is overweight and obesity.

Overweight and obesity are defined as abnormal or excessive fat accumulation inside body that may impair normal health of a person. The status of overweight and obesity in a person is interpreted with the help of body mass index (BMI). According to World Health Organization (WHO), a person is considered as overweight if his/her BMI is ≥ 25 kg/m^2 Similarly, the BMI of obese persons is ≥ 30 kg/m^2 The energy imbalance between calories consumed and calories expended develops obesity and overweight. This energy imbalance is generated due to the changes in dietary and physical activity patterns. If remains untreated, obesity and overweight gives rise to many complications such as cardiovascular disease (heart disease and stroke), diabetes, musculoskeletal disorders (especially osteoarthritis), some forms of cancer such as endometrial, breast, ovarian, prostate, liver, gallbladder, kidney and colon. The risk for these complications increases with increase in BMI in the patients suffering from overweight and obesity.[1]

Many low and middle-income countries are now facing a "double burden" of this disease. Children in low- and middle-income countries are exposed to high-fat, high-sugar, high-salt, energy-dense, and micronutrient-poor foods, which tend to be lower in cost but also, lower in nutrient quality. These dietary patterns, in conjunction with lower levels of physical activity, result in sharp increases in childhood obesity. It was found that 41 million children under the age of 5 were overweight or obese in 2014. These prevalence values prove that worldwide obesity has more than doubled since 1980. According to the data compiled by WHO in 2016, it was found that more than 1.9 billion adults, 18 years and older, were overweight. Of these over 600 million were obese till 2014. It was reported that the prevalence of obesity among women (38.3%) was slightly higher than men (34.3%).[1, 2]

Serial National Surveys in India also demonstrated an increasing trend in the prevalence of obesity. Obesity affects more than 135 million individuals in India. According to Indian Council of Medical Research - India, the prevalence of generalized obesity (BMI 25 kg/m^2) varied from 11.8% in Jharkhand (east India) to 31.3% in Chandigarh (north India). According to the ICMR-INDIAB study, the prevalence of abdominal obesity varied from 16.9% in Jharkhand to 36.3% in Chandigarh. The prevalence of abdominal obesity was found to be high even in underprivileged populations residing in the urban slums of Delhi. It was found that the urban population has higher prevalence rates of obesity as compared to the rural population. The prevalence of obesity was higher in women than men in India too. Thus, Indian population is also suffering majorly from obesity and overweight which is increasing day by day even in the presence of available treatments of obesity and overweight.[3, 4]

Management for overweight and obesity involves the dietary changes, increase in physical activity, weight loss, avoiding fat-rich and sugar-rich foods. These modifications help in the management of obesity during the initial stages but as the BMI rises towards much higher levels, then much efficient approach is needed such as medications. Anti-obesity medical management has shown unsatisfactory results in terms of efficacy, safety and long-term maintenance of weight loss. This poor performance could be attributed to the serious drug side effects caused by synthetic medicines. The pharmacological resolution of obesity could potentially be achieved with that regimen which could target different molecules and levels of the energy homeostasis system.[5, 6]

Green coffee bean extract can be regarded as that supplement which has been clinically proven to be effective as anti-obesity medication. With the high cost of prescription weight loss drugs and the fear of side effects, the general public is turning to nutraceuticals. Thus, green coffee bean extract in the present study (GCB-70) could be the effective and trustable treatment option for overweight and obesity. GCB-70 contains strong antioxidants in the most prominent polyphenol family such as chlorogenic acids (CGA), ferulic acids and *n*-coumarinic acid which also provide protection against the development of complications of obesity and overweight *i.e.* cancer, cardiovascular diseases, diabetes, osteoporosis and neurodegenerative diseases. Chlorogenic acid (CGA) is the main phenolic compound in GCB-70. It has been reported that green coffee readily diffuses through the digestive tract epithelium. The chlorogenic acid actively increases the body's metabolism, increase fatty acid oxidation; reduce triglycerides levels in the liver, and works to inhibit lipase and

amylase pancreatic enzymes. In addition to chlorogenic acid, polyphenol content in coffee is also reported to potentially reduce visceral fat accumulation inside body.[7, 8]

These beneficial characteristics of green coffee bean might help to improve the medical state of patients suffering from overweight or obesity. This was the underline reason to choose Green Coffee Bean extract *i.e.* GCB-70 for evaluating the objectives of present study.

METHODOLOGY

This was an open labeled and single armed study conducted in 100 patients suffering from overweight and obesity. The study population with age between 18 to 65 years was supplemented with GCB-70 for 12 weeks. The subjects were screened for the enrollment on the basis of inclusion & exclusion criteria as given below.

Inclusion criteria

1. Patient agreed to give written as well as audio-visual informed consent.
2. Patients of either sex *i.e.* both male subjects & female subjects.
3. Patient having BMI more than 25 kg/m^2 which will include obese and overweight subjects due to the requirement of the indication.
4. Patients of age between 18 to 65 years.
5. Patient having normally functional thyroid gland (Euthyroid).
6. Patients not receiving any steroids.

Exclusion criteria

1. Patients who were uncooperative.
2. Those female patients who were lactating and pregnant or planning to conceive.
3. Patients who were physically/mentally unwell as certified by physician-in charge.
4. Patient who had participated in any other clinical trial within the last 30 days. The allocation of the product in the enrolled patients was done after screening. Investigational product was consumed by the patients for three months during which capsule of GCB-70 (500mg BD) was given orally to the enrolled subjects. Instructions involving change in the routine physical activity schedules while treating with investigational product were not issued to the enrolled subjects.

Efficacy evaluations

The following investigations were done (after interval of 4 weeks) with each enrolled subject to assess the efficacy of GCB-70.

- Body weight
- BMI
- Waist circumference
- Fasting glucose
- HbA1c
- TSH (Thyroid-stimulating hormone)
- Plasma/serum leptin levels

Safety evaluations

- Hemoglobin level
- Total leukocyte count (TLC)
- Differential leukocyte count (DLC)
- Liver function test

a. Serum glutamic oxaloacetic transaminase (SGOT) activity
b. Serum glutamic pyruvic transaminase (SGPT) activity
c. Alkaline phosphatase (ALP) activity

- Fasting lipid profile

a. Total cholesterol (TC)
b. Triglyceride (TG)
c. Low density lipoprotein (LDL)
d. High density lipoprotein (HDL)

RESULTS

Age

The required age of the subjects in the study was between 18 to 65 years as given in the inclusion criteria. There were 15.2% of the subjects (n=16) with age between 18 to 30 years, 32.4% of the subjects (n=34) were between 30-40 years of age, 27.6% of the subjects (n=29) were between 40-50 years of age, 19% of the subjects (n=20) were between 50-60 years of age and 5.7% of the subjects (n=6) were between 60-65 years of age.

Gender

Both male and female subjects were enrolled in the study. 52.4% of the enrolled subjects were males (n=55) and 47.6% (n=50) of the subjects were females.

Height

The mean height from the complete set of enrolled subjects was calculated to be 162.77cm. The minimum height was 142 cm and maximum height was 182cm in the study population.

Blood pressure

The mean systolic blood pressure of the study population was 120mmHg and mean diastolic blood pressure of the study population was 81mmHg.

Pulse rate

The mean pulse rate of the study population was 79.42 per minute. The minimum pulse rate of the study population was found to be 71 per minute and maximum was 98 per minute.

Efficacy data

Body weight

The mean body weight of the study population decreased with the progress of treatment. The decrease in body weight was shown to be statistically significant (p-value 0.000**) (Table 1) (Fig 1). The percent decrease in mean body weight of the complete study population was observed to be 5.96%.

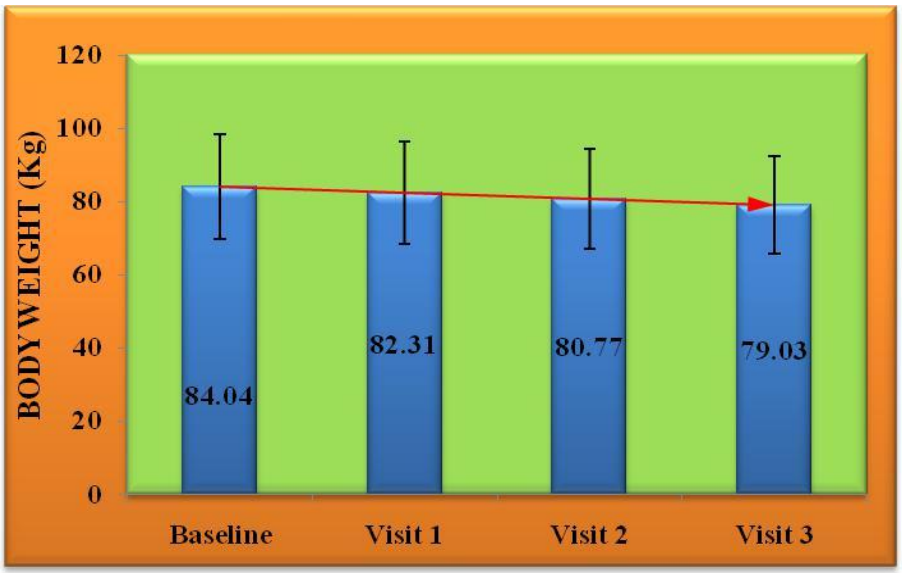

Fig. 1: Body weight of subjects.

The percent of change in the body weight of male subjects was not varied much as compared to the female subjects. Till the completion of the treatment, the mean decrease in body weight was 5.9% in the male subjects and 6.01% in the female subjects.

98.2% of the male subjects and 95.6% of the female subjects have shown decrease in body weight till the end of the treatment.

Body mass index (BMI)

The mean BMI of the study population decreased consistently till the end of the treatment (after 12 weeks). The mean BMI was decreased (5.65%) from 31.45 kg/m^2 at baseline to 29.67 kg/m^2 till the completion of treatment. This decrease in BMI was statistically significant (p-value 0.000**) (Table 1) (Fig 2).

On completion of treatment (Visit 3), there were 15% of the subjects who fall under the range of BMI levels below 25 kg/m^2, 45% of the study subjects had BMI levels between 25 kg/m^2 to 30 kg/m^2, 27% of the study subjects had BMI levels between 30 kg/m^2 to 35 kg/m^2, only 9% of the study subjects had BMI levels between 35 kg/m^2 to 40 kg/m^2 and 4% of the study subjects showed BMI levels above 40 kg/m^2.

Both male and female subjects had similar decreasing trend of BMI. On completion of treatment (Visit 3), 5.92% decrease in BMI was observed in the male subjects and 6.08% decrease in BMI was observed in the female subjects as compared to respective baseline levels.

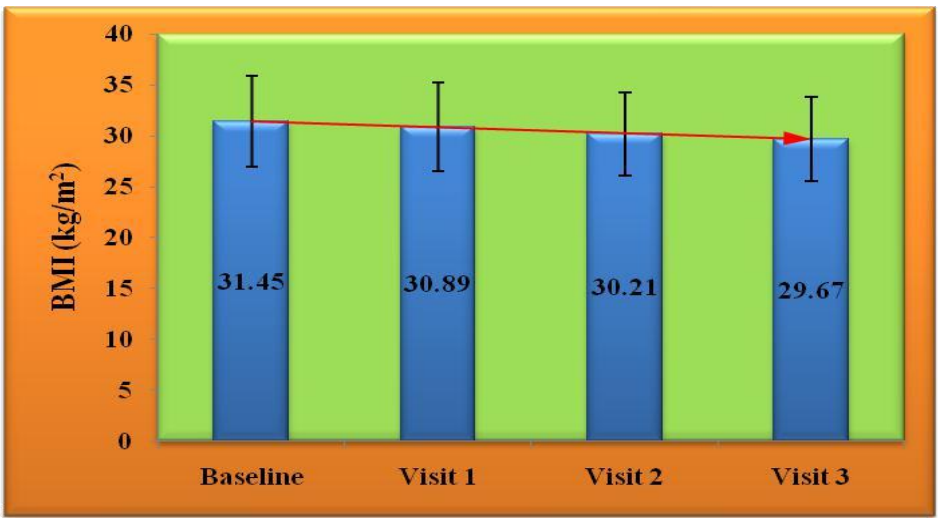

Fig. 2: BMI of subjects.

96% of the study population showed decline in BMI till the end of the treatment, of which 96.4% were male and 95.6% were female subjects.

Waist circumference

The mean waist circumference decreased in the study population after completion of the treatment. This change in waist circumference was statistically significant (p-value 0.000**) (Table 1). The mean waist circumference was 108.10cm at baseline which was decreased to 100.85cm after the complete treatment of the study population (Fig 3).

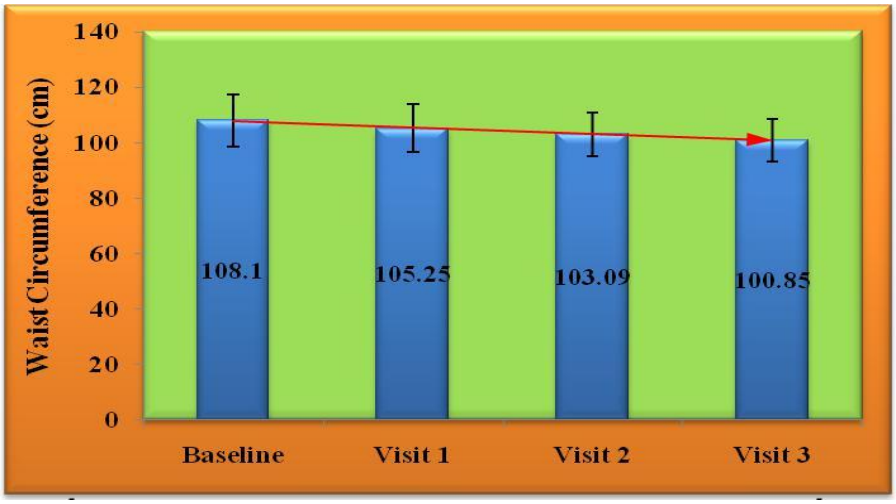

Fig. 3: Waist circumference of subjects,

There was not any major variation in the percentage decrease in the waist circumference of male and female subjects. On completion of the treatment (12^{th} week), percent decrease in the mean waist circumference of male subjects was 6.77% and in the female subjects was 6.62%.

Fasting glucose levels

On completion of the treatment, the decrease in mean fasting glucose levels was statistically significant (p-value 0.000**) as compared to the baseline levels (Table 1). The mean fasting glucose levels were decreased from 109.95 mg/dL at baseline to 95.6 mg/dL on the completion of the treatment (Fig 4).

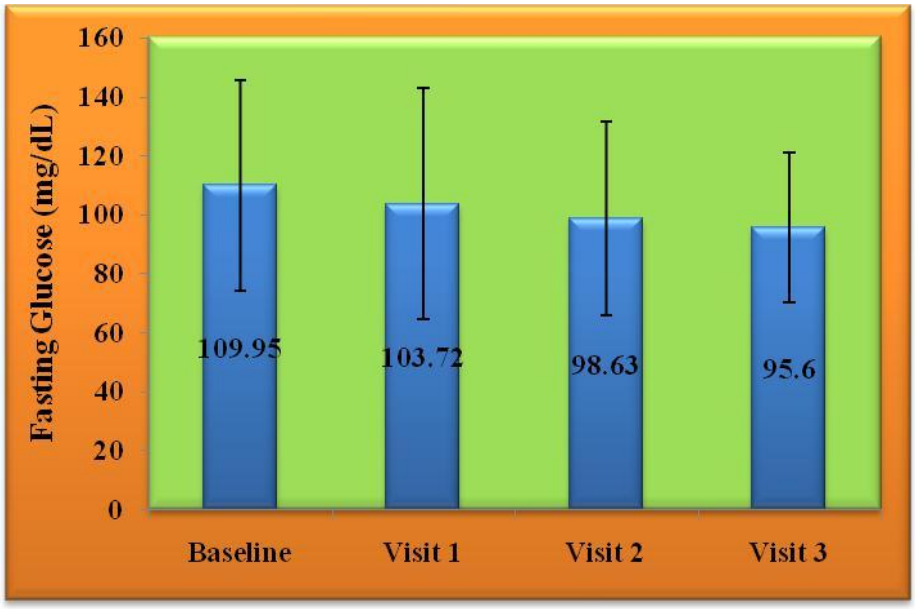

Fig. 4: Fasting glucose of subjects.

After completion of the treatment (12 weeks), 11.99% decrease in the fasting glucose levels was observed in the male subjects and 14.42% decrease was observed in the female subjects.

HbA1c levels

There was statistically significant change in the HbA1c levels on completion of the treatment (p-value 0.000**) (Table 1). Mean HbA1c levels were decreased from 6.39% at baseline to 6.01% on completion of the treatment (Fig 5).

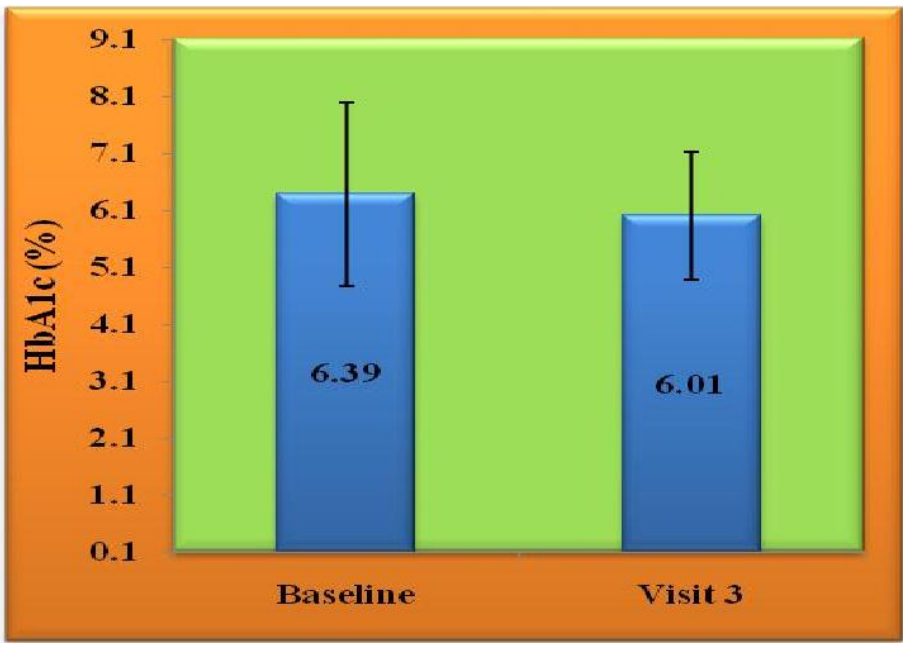

Fig. 5: HbA1c of subjects.

Both male and female subjects showed decrease in HbA1C levels. On the completion of treatment, there was 4.77% mean decrease in the HbA1c in male subjects where as the female subjects showed 7.34% mean decrease in the HbA1c.

Thyroid stimulating hormone (TSH)

There was statistically significant decrease in the mean TSH levels (p-value 0.000**) (Table 1).

The TSH levels were decreased from 2.77µIU/mL at baseline to 2.38µIU/mL on completion of the treatment (Fig 6).

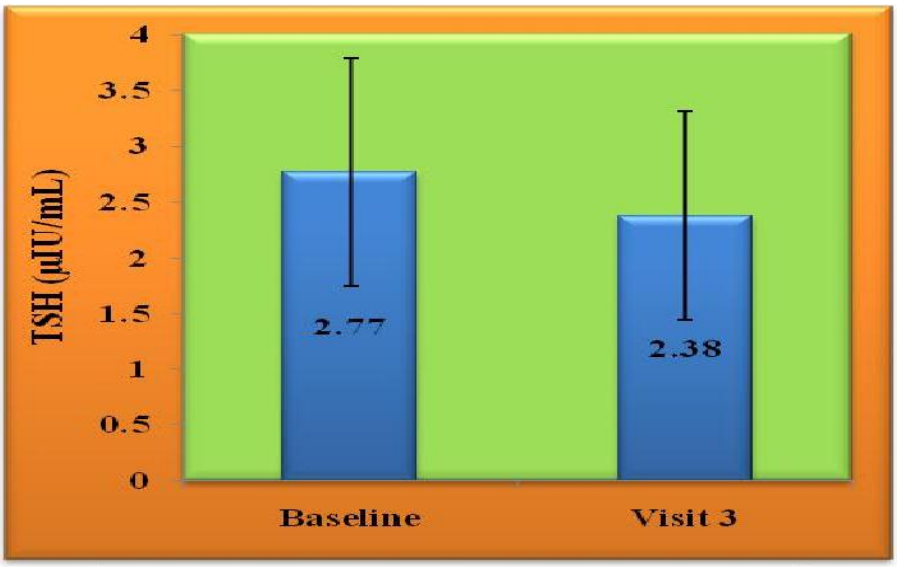

Fig 6: TSH of subjects.

No major variations in the percent of change in TSH levels were observed between the male and female subjects. On completion of the treatment at Visit 3, the mean decrease in TSH levels of the male subjects was 14.33% and in the female subjects was 13.43%.

Plasma leptin levels

The decrease in plasma leptin levels was statistically significant (p-value 0.000**) on completion of the treatment. At baseline, the mean plasma leptin level was 4.56ng/mL which was decreased to 3.94ng/mL on completion of the treatment (Table 1) (Fig 7).

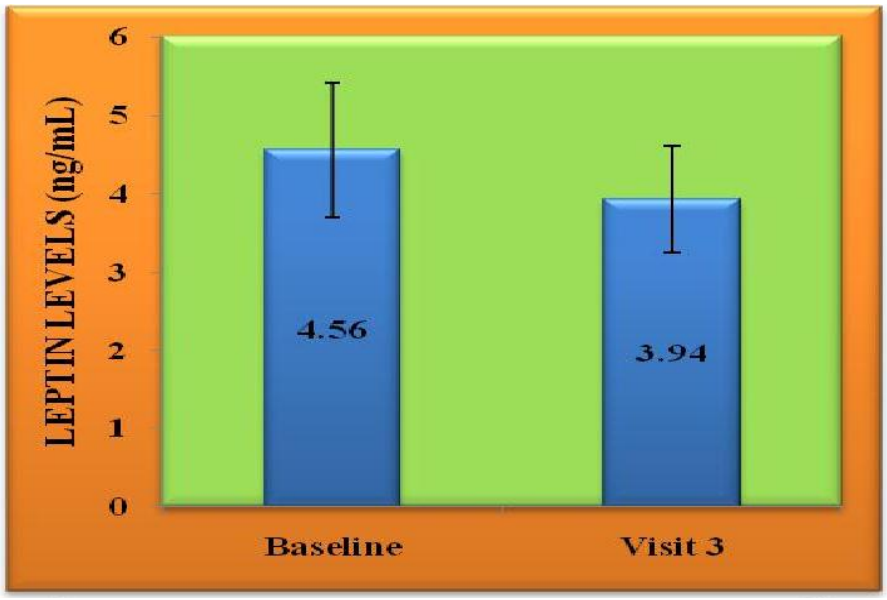

Fig. 7: Plasma leptin levels.

The change in the plasma leptin levels between male and female subjects were similar. On completion of the treatment (at Visit 3), the mean decrease in plasma leptin levels in the male subjects was 13.03% and in the female subjects was 14.29% as compared to the respective baseline levels.

Safety data

The response of GCB-70 by patients towards safety parameters have shown in Table 2 and it has been evaluated that non-significant change was observed in these parameters after completion of the treatment. All the hematological and biochemical parameters of the study population were within normal range on completion of the treatment.

Table 1: Statistical data of efficacy parameters.

		Mean ± Std. Deviation	p-value
	Baseline	84.04 ± 14.458	.000**
Body Weight	Visit 1 (4th week)	82.31 ± 14.010	
	Visit 2 (8th week)	80.77 ± 13.579	
	Visit 3 (12th week)	79.03 ± 13.226	
BMI	Baseline	31.45 ± 4.491	.000**
	Visit 1 (4th week)	30.89 ± 4.333	
	Visit 2 (8th week)	30.21 ± 4.125	
	Visit 3 (12th week)	29.67 ± 4.154	
Waist Circumference	Baseline	108.10 ± 9.413	.000**
	Visit 1 (4th week)	105.25 ± 8.529	
	Visit 2 (8th week)	103.09 ± 7.965	

	Visit 3 (12th week)	100.85 ± 7.575	
Fasting glucose	Baseline	109.95 ± 39.598	
	Visit 1 (4th week)	103.72 ± 39.140	
	Visit 2 (8th week)	98.63 ± 32.917	
	Visit 3 (12th week)	95.60 ± 25.489	
TSH	Baseline	2.7744 ± 1.02387	
	Visit 3 (12th week)	2.38 ± .933	
Plasma Leptin	Baseline	4.56 ± .867	
	Visit 3 (12th week)	3.94 ± .685	

Table 2: Statistical data of safety parameters.

		Mean ± Std. Deviation	p-value
AST/GOT	Baseline	38.48 ± 21.380	.002**
	Visit 3 (12th week)	33.18 ± 15.109	
ALT/GPT	Baseline	47.28 ± 26.212	.014*
	Visit 3 (12th week)	41.49 ± 23.722	
ALP	Baseline	96.95 ± 32.623	.000**
	Visit 3 (12th week)	87.05 ± 24.576	
HbA1c	Baseline	6.39 ± 1.614	.000**
	Visit 3 (12th week)	6.01 ± 1.129	
Triglycerides (TG)	Baseline	155.52 ± 84.713	.020*
	Visit 3 (12th week)	143.32 ± 66.789	
Total cholesterol (TC)	Baseline	165.48 ± 37.795	.000**
	Visit 3 (12th week)	152.40 ± 33.140	
LDL Cholesterol	Baseline	95.80 ± 30.198	.007**
	Visit 3 (12th week)	90.59 ± 28.705	
HDL cholesterol	Baseline	39.96 ± 8.873	.000**
	Visit 3 (12th week)	44.40 ± 6.621	
Hemoglobin (Hb)	Baseline	13.31 ± 1.589	.000**
	Visit 3 (12th week)	14.00 ± 1.262	
Total Leukocyte Count (TLC)	Baseline	7.79 ± 1.919	.000**
	Visit 3 (12th week)	7.14 ± 1.164	
Neutrophils	Baseline	59.16 ± 6.675	.141ns
	Visit 3 (12th week)	58.12 ± 3.813	
Eosinophils	Baseline	4.57 ± 3.187	.025*
	Visit 3 (12th week)	3.82 ± 2.181	
Lymphocytes	Baseline	31.28 ± 6.048	.250ns
	Visit 3 (12th week)	32.01 ± 3.090	
Monocytes	Baseline	4.47 ± 2.248	.000**
	Visit 3 (12th week)	5.60 ± 2.122	
Basophils	Baseline	0.51 ± 0.404	.048*
	Visit 3 (12th week)	0.42 ± 0.246	

DISCUSSION

Green coffee bean extract has shown medicinal properties in many clinical studies till date. It contains many bioactive components which contribute to exert its anti-obesity property in humans and animals as well. Green coffee beans are specifically chosen for the given purpose in the present study because if they are roasted, their major bioactive components such as polyphenols are broken down. One of those bioactive polyphenols found in green coffee bean extract is 'chlorogenic acid' which is considered as the major reason behind the effective anti-obesity property of it. Besides contributing in the anti-obesity effect of green coffee bean extract, chlorogenic acid also helps to maintain blood sugar levels, blood pressure and heart diseases. Chlorogenic acid has the tendency to melt down body fat by targeting fat metabolism inside body resulting in superior health and fitness without much physical exercise and diet programs.[9, 10]

The animal studies reported that green coffee bean extract suppress the accumulation of hepatic triglycerides inside body. Some authors have also reported that the anti-obesity effect of green coffee bean extract might be mediated via alteration of plasma adipokine level and body fat distribution and down-regulating fatty acid and cholesterol biosynthesis, whereas up-regulating fatty acid oxidation and peroxisome proliferator-activated receptor alpha (PPARα) expression in the liver.[11]

In the present clinical study on obese and overweight subjects, GCB-70 has been found to decrease the body weight of the affected patients probably by the mechanism given above *i.e.* by managing body fat distribution. It has been observed from the clinical data in Fig 1 that after the consumption of GCB-70 for 12 weeks, the mean body weight of the subjects reduced from 84.04 kg at baseline to 79.03 kg till the completion of the treatment (Visit 3). GCB-70 is also able to manage obesity and overweight in both male and female subjects. The mean decrease in body weight was 5.9% in the male subjects and 6.01% in the female subjects.

Along with body weight, BMI (body mass index) of the enrolled subjects was also observed to be reduced. As given in Fig 2, BMI was shown to be reduced from 31.45 kg/m^2 at baseline to 29.67 kg/m^2 on completion of the treatment. This effect was also observed in male and female subjects and found that BMI was decreased up to 5.92% in the male subjects and up to 6.08% in the female subjects on completion of treatment (Visit 3).

In obese and overweight patients, waist circumference is also taken as one of the markers to know the condition of the patient because increase in body weight influences waist fat to a much higher levels. It is highly sensitive and specific measure of upper body fat in obese and overweight patients. It is valuable for identifying patients at the risk of developing metabolic complications such as dyslipidemia, insulin resistance and cardiovascular complications in the obese patients. In the present clinical study, the management of fat distribution by green coffee bean extract which resulted in decrease in body weight and BMI, also effectively reduced the waist circumference of the enrolled subjects. It was observed that the waist circumference was decreased from 108.1cm at baseline to 100.85cm till the completion of the treatment with GCB-70 consumption as depicted by Fig 3. The effectiveness of GCB-70 in reducing waist circumference in male and female subjects was observed to be almost equal as the decrease in mean waist circumference of male subjects was 6.77% and in the female subjects was 6.62% till the completion of the treatment.[12]

It has been reported by researchers that green coffee bean extract influence glucose concentration also. Chlorogenic acid in green coffee bean extract helps in glycaemic control by inhibiting glucose-6-phosphatase enzyme activity. This enzyme plays an important role in the homeostatic control of blood sugar concentration because it is responsible for the conversion of glucose-6-phosphate into glucose which is then capable of passing into the general circulation. Inhibition of hepatic glucose-6-phosphatase causes a reduction in the hepatic production of glucose and consequently decreases abnormally high levels of glucose in the blood. GCB-70 might be effective due to this mechanism to decrease fasting glucose levels in the obese and overweight subjects. As given in Fig 4, the mean fasting glucose levels were decreased from 109.95 mg/dL at baseline to 95.6 mg/dL on the completion of the treatment in the enrolled subjects. Fig 5 also depicts the anti-diabetic action of GCB-70 in the obese and overweight population because GCB-70 reduced mean HbA1c levels from 6.39% at baseline to 6.01% on completion of the treatment.[13, 14]

GCB-70 was also effective at hormonal levels in the enrolled population. It was found in the previous literature that increase in thyroid stimulation hormonal (TSH) is in conjunction with BMI in obese patients. If the TSH levels are increased in the obese patients, they are due to the consequence of both fat mass accumulation and the energy-imbalance in the obese patients. In the present study, the TSH levels were decreased from 2.77µIU/mL at baseline to

2.38µIU/mL on completion of the treatment as given in Fig 6. This can also be correlated with BMI which was also decreased in the obese and overweight subjects by GCB-70.[15]

The circulating leptin levels inside body are elevated under the effect of obesity which decreases the sensitivity to leptin, originating the situation of leptin resistance. Due to leptin resistance, many actions of leptin get affected including food intake, nutrient intestinal absorption, intermediate metabolism and insulin sensitivity, leading to dysregulation of the energy balance. Satiety is also associated with leptin production. Under normal conditions, when leptin is released in the blood, brain signals the body to eat food. In leptin resistance, interaction between leptin and brain get imbalanced due to which more and more leptin is produced which continues to signal the body to consume food, resulting in body weight gain. Green coffee bean treatment has been reported to manage leptin concentrations in overweight and obese subjects. It lowers the production of leptin which balances the attachment of leptin on leptin receptors inside body. This might help in normalizing the interaction of leptin with brain through blood brain barriers in obese patients. In the present study also, Fig 12 depicts that GCB-70 was also capable to reduce the mean leptin levels from 4.56ng/mL at baseline to 3.94ng/mL on completion of the treatment. This results in the management of leptin levels inside body controlling food intake under satiety and thus, managing body weight.[16, 17]

These findings from the present study conclude that GCB-70 consumption is safe and effective in the management of obesity. GCB-70 has the potential to manage fat distribution and glucose concentration to control all the markers of obesity and overweight taken in the present study. Thus, to lessen the side effects and increasing the improvement in the condition of obesity in 12 weeks in both male and female genders, this natural supplement in the form of GCB-70 can be opted above other synthetic medications.

ACKNOWLEDGEMENTS

The authors thank Dr. Rajesh Sehgal, Pharma Instinct, Chandigarh ,India, for all cooperation and technical support to this clinical study.

FUNDING

The study was funded by Chemical Resources, Panchkula, Haryana, India.

Consent to Publish

All authors have read, consented and approved the final manuscript for publication. This manuscript doesn't contain any individual person's data.

Availability of Data and Material

NV have appropriately stored all the data in their Laboratories Storage Facility in Kings Georges Medical University, Lucknow, Uttar Pradesh, India.

Conflict of Interest

NV is the principal investigator and MM is the co-principal investigator, organized, coordinated the study.VA is Research Assistant and KT and GL are coordinators from Funding Agency

REFERENCES

1. WHO Fact Sheet: Obesity and overweight. 2016 http://www.who.int/mediacentre/factsheets/fs311/en/.
2. Ogden CL *et al.*: Prevalence of obesity among adults and youth: United States, 2011–2014. NCHS Data Brief, 2015; 219.
3. Shrivastava U *et al.*: Obesity, diabetes and cardiovascular diseases in India: Public health challenges. *Current Diabetes Reviews*, 2017; 13: 65-80.
4. Akholkar PJ and Gandhi AA: Prevalence of obesity in diabetic and non-diabetic population. *Int J Res Med Sci*, 2015; 3(8): 2114-2117.
5. Khairy M and Rajkhowa M: Effect of obesity on assisted reproductive treatment outcomes and its management: a literature review. *The Obstetrician and Gynaecologist*, 2017; 19(1): 47–54.
6. Valsamakis G, Konstantakou P and Mastorakos G: New targets for drug treatment of obesity. *Annual Review of Pharmacology and Toxicology*, 2017; 57: 585-605.
7. Setyono J *et al.*: The Effect of Orlistat, Green Coffee Bean Extract, and Its Combinations on Lipid Profile and Adiponectin Levels. *Jurnal Ners*, 2014; 9(1): 26–34.
8. Budryn G *et al.*: Green and roasted coffee extracts as antioxidants in βTC3 cells with induced oxidative stress and lipid accumulation inhibitors in 3T3L1 cells and their bioactivity in rats fed high fat diet. *Eur Food Res Technol* 2017; doi:10.1007/s00217-017-2843-0.

9. Sudeep HV et al.: Biomechanism of chlorogenic acid complex medicated plasma free fatty acid metabolism in rat liver. *BMC Complementary and Alternative Medicine*, 2016; 16: 274.
10. Chatterjee B and Patel T: Green coffee bean extract – Infuse obesity. *International Journal of Innovative Research & Development*, 2015; 4(11): 237-239.
13. Onakpoya I, Terry R and Ernst E: The use of green coffee extract as a weight loss supplement: A systematic review and meta-analysis of randomised clinical trials. *Gastroenterol Res Pract*, 2011; 2011: 382852.
14. Bacopoulou F et al.: Waist circumference, waist-to-hip ratio and waist-to-height ratio reference percentiles for abdominal obesity among Greek adolescents. *BMC Pediatrics*, 2015; 15: 50.
15. Ibarra A, Roller M and Dikansky J: Effects of a decaffeinated green coffee bean extract on body weight control by regulation of glucose metabolism. *Google Patents*, 2016; US9358264 B2.
16. Chen L, Tuo B and Dong H: Regulation of intestinal glucose absorption by ion channels and transporters. *Nutrients*, 2016; 8(1): 43.
17. Betry C *et al.*: Increased TSH in obesity: Evidence for a BMI-independent association with leptin. Diabetes & Metabolism, 2015; 41(3): 248–251.
18. Sainz N et al.: Leptin resistance and diet-induced obesity: central and peripheral actions of leptin. *Metabolism Clinical and Experimental*, 2015; 64: 35-46.
19. Choi BK et al.: Green coffee bean extract improves obesity by decreasing body fat in high-fat diet-induced obese mice. Asian Pacific Journal of Tropical Medicine, 2016; 9(7): 635-643.