African Mango (*Irvingia gabonensis*) Extract for Weight Loss: A Systematic Review

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Abstract: *Objective*: The objective of this review is to assess the effectiveness and safety of African mango (*Irvingia gabonensis)* extract on weight loss in humans.

Design: A systematic review of articles evaluating the effect of African mango, IGOB131, dikanut, bush mango or *Irvingia gabonensis* on weight and obesity was conducted.

Population: Three randomized, controlled trials were identified and met criteria for inclusion in the review with a total of 214 subjects receiving *Irvingia gabonensis* at various doses alone or in combination with other dietary supplements versus placebo over a period of four to ten weeks.

Results: All studies demonstrated a decrease in weight ranging from 4-12kg ($p<0.05$). Other measures of weight loss including body fat percentage ($p<0.05$) and waist circumference ($p<0.01$) were also significantly decreased by *Irvingia gabonensis*. Improvements were also seen in total cholesterol, low density lipoprotein and fasting blood glucose. Few adverse events were reported but include insomnia, flatulence and headache.

Conclusions: *Irvingia gabonensis* demonstrates potential for significant weight loss of up to 12 kilograms in overweight and obese subjects over a period of 10 weeks with few reported adverse events. Larger studies including subjects from multiple countries for 6 to 12 months should be conducted to elucidate the long-term effects in various populations.

Keywords: African mango, *Irvingia gabonensis*, weight, obesity, adiponectin.

INTRODUCTION

Obesity is a worldwide epidemic with 312 million people currently classified as obese [1]. The Center for Disease Control (CDC) reports that over one-third of adults in the United States are obese with a body mass index (BMI) greater than or equal to 30 kg/m^2 [2]. It has been estimated that if obesity rates in the United States continue at the same pace over the next twenty years, adult obesity could be as high as 44 percent in each state and as high as 60 percent in 13 states [3]. Obesity remains a preventable cause of mortality, and is also associated with multiple chronic diseases and psychosocial issues [4]. The obesity epidemic also contributes to over $120 billion in medical spending with 17% attributed to prescription drugs [5]. Over the counter weight loss products comprise a $3 billion dollar industry with future sales predicted to only increase [6]. Although most over the counter weight loss products are unregulated by the Food and Drug Administration (FDA), they offer several advantages to consumers including access without a prescription or healthcare provider visit, decreased costs and potentially fewer adverse effects.

While prescription weight loss products such as orlistat and phentermine/topiramate have demonstrated a 3.5-9 kg weight loss over 1 year, over the counter products have demonstrated 0-3.3kg weight loss over 4 weeks to 6 months in randomized, controlled trials [7-9]. The mechanisms for weight loss of many natural products are not well understood but are proposed to be a result of decreased fat absorption, decreased fat synthesis or increased insulin sensitivity [9].

African mango (*Irvingia gabonensis*), also known as the Dikanut or bush mango in its native Cameroon, first gained widespread attention in the United States in 2010 after the results of randomized, controlled trials were reported by the media. African mango was studied for its weight loss potential after observing tribes using the seed as a dietary staple had slim builds and a decreased incidence of cardiovascular disease [10]. The seeds of the mango-like fruit contain high soluble fiber, which may act as a bulk forming laxative resulting in gradual absorption of dietary sugar and reduce the formation of adipocytes [11, 12].

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Adipogenesis is a dynamic process. Obesity is marked by the enlargement of adipocytes secondary to triglyceride accumulation. Transcriptional factors such as peroxisome proliferator-activated receptor gamma (PPAR gamma) is a positive effector and stimulates adipocyte differentiation. Adiponectin, a key cytokine in adipogenesisis, has been found to possess both anti-inflammatory and antiatherogenic properties and be cardioprotective in both mice and humans. Leptin is a satiety hormone which stimulates thermogenesis while Glycerol-3-Phosphate dehydrogenase (G3PDH) is crucial in formation of fatty acids from glycerol [1, 12].

The *in vitro* effects of *Irvingia gabonensis* (*IG*) seed extract on adipogenesis were evaluated using adipocyte cells from mice [12]. Adipocytes were incubated with varying concentrations of *Irvingia gabonensis* and intracellular triglyceride levels, G3PDH concentration, PPAR gamma expression, lectin levels and adiponectin expression were evaluated. Triglyceride and G3PDH concentrations decreased in the presence of *IG* compared to baseline values ($p < 0.05$). *Irvingia gabonensis* also decreased the expression of PPAR gamma ($p < 0.05$), lectin levels ($p < 0.05$), and up regulated adiponectin ($p < 0.05$) compared to baseline.

The objective of this review is to assess the effectiveness and safety of African mango extract on weight loss in humans.

MATERIALS AND METHODS

Searches were conducted in February 2013 using Medline, DARE, Cochrane and the reference list of included papers. Searches were limited to research in humans. Search terms included African mango, IGOB131, dikanut, bush mango, *Irvingia gabonensis* AND weight, obesity. Any outcome of weight (e.g. change in weight, body fat or BMI) or markers of obesity (e.g. adiponectin) were included for analysis. Randomized controlled trials, cohort studies and case reports were included due to limited anticipation of available studies.

RESULTS

Three randomized, controlled trials were identified and met criteria for inclusion in the review (Table **1**). No studies identified were excluded.

The first study published in 2005 was a randomized, double blind, placebo-controlled crossover investigation [11]. Obese subjects (n=40) were chosen between the ages of 19 and 55. The determination of obesity was not clearly defined. Randomization procedures were not described by the authors, however the methods for capsule preparation and blinding were explained. Patients were excluded if they had diabetes mellitus, were pregnant or lactating. Patients were treated for a period of 4 weeks with three capsules of *Irvingia gabonensis* seed extract 350mg or oat bran placebo three times a day with warm water a half hour between meals for a total of nine capsules daily. Subjects were instructed to eat a low fat diet of 1800 Kcals and were interviewed about their diet and exercise habits. Baseline diet and exercise habits were not reported. Subjects body weight, body fat, and waist and hip circumference were measured weekly for 4 weeks. At the end of 2 and 4 weeks, blood pressure and blood samples were collected on each patient to measure concentrations of total cholesterol, triglycerides, HDL-cholesterol, LDL-cholesterol and glucose. A paired student t test was used for statistical analysis.

Irvingia gabonensis showed a significant decrease in weight from baseline after 2 and 4 weeks of treatment with (mean ± SEM) 2.91 ± 1.48% ($p < 0.0001$) and 5.6 ± 2.7% ($p < 0.0001$), respectively. Placebo had a reduction of 1.32 ± 0.41% ($p<0.02$) at the end of 2 weeks and 2.23 ± 1.05% ($p<0.05$) at the end of four weeks. *Irvingia gabonensis* decreased weight significantly more than placebo ($p<0.01$). Waist circumference and hip circumference were also reduced with 5.07 ± 3.18% ($p < 0.0001$) and 3.42 ± 2.12% ($p < 0.0001$); however, body fat percentage was not reduced in patients taking *Irvingia gabonensis*. Plasma total cholesterol, triglycerides and LDL were also reduced by 39.21% (p-value not reported), 44.9% ($p<0.05$) and 45.58% (p-value not reported) respectively in patients taking *Irvingia gabonensis* as well as an increase in HDL of 46.852% (p-value not reported). Blood glucose levels were also reduced 32.36% ($p<0.05$) in patients taking *Irvingia gabonensis*. Patients in the placebo group did not show any significant changes in these blood lipid components; however, patients in the active treatment group were noted to have higher lipid levels at baseline (no baseline comparison reported). There was also a decrease in the systolic blood pressure of 3.75 mmHg in the active group after the second week of treatment and this effect remained after 4 weeks (no p-value reported). However, the blood pressure change of from baseline was significantly greater in the placebo group (10.2 mmHg, $p<0.001$) over the course of the trial.

Limitations to this study include the lack of clarity in the study-design. The authors mention a crossover

Table 1: Included Studies of *Irvingia gabonensis* (IG) in Weight Loss

Study	Design	Population	Intervention	Results
Ngondi JL, 2005	Randomized Double-blind Crossover	n=40 Obese subjects Age 19-55 years	*IG* 150mg (n=28) vs. placebo (n=12) 3 capsules TID 4 weeks	Weight loss *IG* 4kg vs. placebo 0.1kg (p<0.01)
Oben JE, 2008	Randomized Double-blind	n=72 Overweight and obese subjects Age 21-44 years	Cissus quadrangularis (CQ)150mg (n=24) vs. *CQ-IG* 250mg (n=24) vs. Placebo (n=24) 1 capsule BID 10 weeks	Weight loss *CQ* 8.8kg vs. *CQ-IG* 11.9kg vs placebo 2.1kg (p<0.05) Body fat *CQ* 14.6% vs. *CQ-IG* 11.9% vs. 1.32% (p<0.05) Waist size *CQ* 8.6cm vs. *CQ-IG* 21cm vs. placebo 1cm (p<0.001)
Ngondi JL, 2009	Randomized Double-blind	n=102 Overweight and obese subjects Age 19-50	*IG* 150mg (n=52) vs. placebo (n=50) 1 capsule BID 10 weeks	Weight loss *IG* 12.8kg vs. placebo 0.7kg (p<0.01) Body fat *IG* 6.3% vs. placebo 2% (p<0.05) Waist size *IG* 16.2cm vs. placebo 5.3 cm (p<0.01)

design in their methods, however washout periods are not clearly described and subjects were not equally randomized to each treatment group *(Irvingia gabonensis* n=28 and placebo n=12). Additionally baseline differences between the active and placebo groups were not explained or analyzed, including differences in weight at baseline (*Irvingia gabonensis* 105kg and placebo 79kg). The weight loss reported by the authors for *Irvingia gabonensis*is comparable to that of other over-the-counter weight loss products (*Irvingia gabonensis* 4kg vs. placebo 0.1kg (p<0.01)). Although body weight was decreased, the study did not demonstrate a decrease in total body fat. The recommended low fat diet may also have contributed to overall weight loss in the study. No adverse effects were reported by the authors and several p-values were also not reported. Considering the mechanism of action, it is possible that *Irvingia gabonensis* results in a loss of water weight rather than body fat, and as the study was only 4 weeks in duration the long-term weight loss effects of *Irvingia gabonensis* cannot be determined from this study.

Irvingia Gabonensis (*IG*) in combination with a different weight loss supplement, *Cissus quadrangularis (CQ)* was compared to *C. quadrangularis* alone in a 2008 study [13]. *C. quadrangularis* acts as an antioxidant as well as inhibits digestive enzymes lipase and amylase. A randomized, double blind, placebo-controlled study was conducted over 10 weeks in 72 patients. Overweight or obese subjects were included with an average BMI > 26 kg/m^2 and an average age of 29.3 years. The exact BMI average and baseline group comparisons were not reported. Subjects were excluded if examination and screening tests revealed diabetes, pregnancy, or lactation. Participants were randomized to three groups: placebo (n=24), *C. quadrangularis* 150mg (n=24), and *C. quadrangularis* – *Irvingia gabonensis* combination 250mg (n=24). Capsules were administered twice daily before meals with 8-10 ounces of water. During the study, measurements of body weight, body fat, waist size, total cholesterol, LDL cholesterol, and fasting blood glucose were obtained at baseline and weeks 4, 8, and 10.

At week four, the *CQ* group had lost significantly more weight than the placebo group (3.15kg vs. +0.71kg, p<0.05) and this difference was maintained throughout the study to week 10 (8.73kg vs. 2.06kg, p<0.001). However, the combination group *CQ-IG* showed no significant difference from placebo at four weeks although a significant difference emerged at

week 8 (8.88kg vs. 1.31kg, p<0.01) and remained at week 10 (11.84kg vs. 2.06kg, p<0.0001). The combination *CQ-IG* group also lost significantly more weight at weeks 8 and 10 than the *CQ*-alone group (p<0.05 and p<0.0001, respectively). The combination group experienced an 11.86% weight decrease (p<0.05 compared to baseline) at week 10 while the *CQ*-alone group experienced a 8.82% weight decrease (p<0.05 compared to baseline). The *CQ-IG* group demonstrated a weight loss benefit at 4 weeks that continued to increase throughout the 10 week study. No analysis was performed between groups for percentage weight change. Percent body fat decreased significantly after 10 weeks in both treatment groups compared to placebo (*CQ-IG* 7.15% (p<0.05), *CQ*-alone 4.84% (p<0.05), placebo 1.32%) and the combination group demonstrated a significant difference in body fat at 10 weeks compared to the *CQ*-alone group (p<0.05). Body fat decreases did not demonstrate significance at the earlier time comparisons of 4 and 8 weeks. Although reported waist sizes differed between groups at baseline, a significant decrease in waist size was reported in both treatment groups at 10 weeks compared to placebo (*CQ-IG* 21.88cm (p<0.0001), *CQ*-alone 8.63cm (p<0.001), placebo 1.03 cm). The combination group underwent a significantly greater decrease in waist size compared to *CQ*-alone (p<0.001). Differences in waist size were shown at week eight and continued to increase through week 10.

Serological measurements were obtained and consisted of total cholesterol, LDL level, and fasting blood glucose levels. Although reported plasma total cholesterol differed between groups at baseline, a significant decrease in total cholesterol was reported in both treatment groups at 10 weeks compared to placebo (*CQ-IG* 67.88mg/dL (p<0.001), *CQ*-alone 40.13mg/dL (p<0.001), placebo +3.27mg/dL). The combination group underwent a significantly greater decrease in total cholesterol compared to *CQ*-alone (p<0.0001) with a reported difference of 17.6%. Differences in total cholesterol in the *CQ-IG* group appeared at 4 weeks and continued to increase throughout the 10 weeks. Although reported LDL cholesterol differed between groups at baseline, a significant decrease in LDL was reported in both treatment groups at 10 weeks compared to placebo (*CQ-IG* 41.93mg/dL (p<0.05), *CQ*-alone 16.21mg/dL (p<0.001), placebo 2.26mg/dL). The combination group underwent a significantly greater decrease in LDL compared to *CQ*-alone (p<0.001) with a reported difference of 28.5%. Differences in LDL in the *CQ-IG* group appeared at 4 weeks and continued to increase throughout the 10 weeks. Although reported fasting blood glucose (FBG) differed between groups at baseline, a significant decrease in FBG was reported in both treatment groups at 10 weeks compared to placebo (*CQ-IG* 27.57mg/dL (p<0.001), *CQ*-alone 11.94mg/dL (p<0.001), placebo 2.11mg/dL). The combination group underwent a significantly greater decrease in FBG compared to *CQ*-alone (p<0.001) with a reported difference of 16.6%. Differences in FBG in the *CQ-IG* group appeared at 4 weeks and continued to increase throughout the 10 weeks. Adverse events experienced in the trial included headache (n=4), insomnia (n=4), and flatulence (n=5) although the breakdown between the different treatment groups was not reported.

Although this study was larger than the first with a longer duration, this study remains limited by the small sample size and short trial duration. Many of the treatment observations were not observed until beyond 4 weeks, which was the length of the first published study. Addition of body fat percentage, waist circumference and metabolic parameters of cholesterol and FBG add to the evidence of *Irvingia gabonensis's* benefits in the obese population. However, use of *CQ* in combination with *IG* limits the applicability of the results to those supplements containing only *IG*. Baseline differences between groups were not analyzed by the authors and may limit the impact of the reported results.

The third published study was a randomized, double-blind, placebo controlled trial of men and women aged 19 to 59 years (n=120) in overall good health, with a BMI between 26 and 40 kg/m^2 [14]. Volunteers were randomized into 2 groups with 60 volunteers receiving a placebo and 60 volunteers receiving 150 mg of *Irvingia gabonensis* 30 to 60 minutes before lunch and dinner. Of the 120 patients who were selected to participate, 18 volunteers dropped out of the study. The reasons for dropout were influenza (n=3), dry mouth (n=3), not experiencing rapid weight loss (n=10), and no reason given (n=2). Primary endpoints were body weight along with fasting blood samples taken at baseline and at 4, 8, and 10 weeks to measure total cholesterol, LDL cholesterol, fasting blood glucose, C-reactive protein, adiponectin and leptin levels.

Weight decreased in both the placebo and *IG* treatment groups, however after 10 weeks, weight loss

was more significant in the *IG* treatment group than the placebo group (12.8kg vs. 0.7kg, p<0.01). Waist circumference was also significantly decreased in the *IG* group compared to the placebo group (16.19cm vs. 5.3cm, p<0.01). Body fat was decreased 6.3% in the active treatment group and 2.9% in the placebo group (p<0.01).

Metabolic parameters associated with weight loss were also assessed and found to be significantly different from placebo. Among these leptin (16ng/ml vs. 2.9ng/ml, p < 0.01), LDL cholesterol (22.44ng/ml vs. 3.75ng/ml, p < 0.01), total cholesterol (39.8ng/ml vs. 2.8ng/ml, p < 0.05), C reactive protein (0.78mg/l vs. 0.01mg/l, p<0.01), fasting blood glucose (19.3mg/dl vs. 4.3mg/dl, p < 0.05), and adiponectin (+19.4mg/L vs. +2.8mg/L, p < 0.05) were all found to be significantly different at the end of the treatment period. Adverse effects of *Irvingia gabonensis* experienced were headache (n=5), flatulence (n=6), and difficulty sleeping (n=6). The adverse effects occurred similarly in the placebo and the treatment group.

This study was the largest of the three reported studies; however, the duration of 10 weeks is comparable to the other studies. Weight loss and decrease in waist circumference was similar in this study to that experienced by the combination group of *CQ-IG* in the previous study. The decrease in body fat percentage was not as large as in the combination study. Adverse effects in the second and third studies were also similar. With only a placebo comparator group, this study most clearly demonstrates the benefits of *IG* on weight loss in humans.

DISCUSSION

The three included trials investigated the use of *Irvingia gabonensis* for weight loss in over 200 patients over a period of 4 to 10 weeks. All studies demonstrated a decrease in weight ranging from 4-12kg. Other measures of weight loss including body fat percentage and waist circumference were also significantly decreased by *Irvingia gabonensis*. Improvements were also seen in total cholesterol, LDL and fasting blood glucose, which may decrease the overall hazard for overweight and obese subjects at risk for metabolic syndrome. Strengths of the studies include multiple parameters demonstrating weight loss and randomized, controlled trial designs. However, there were multiple limitations to the studies. Each study was conducted in a similar population within one country by one group of authors. Baseline descriptions of subjects were limited, which makes external validity and comparison to individual patients difficult. Additionally, the regimen of *Irvingia gabonensis* administration was different in each study limiting the ability to translate the study results into clinical practice. Long-term benefits and risks of *Irvingia gabonensis* are unknown due to the short-term studies and lack of adverse event reporting. Additionally, drug interactions were not considered in any of the included studies. Two of the three studies included overweight subjects in addition to those who were obese, although the breakdown of overweight and obese subjects was not reported. Data in underweight, normal weight and morbidly obese subjects is therefore limited. Likewise, the data cannot be extrapolated to adults over age 55. Additionally, data on the diet and exercise habits of subjects were not included in the studies, which may make application to subjects on a Western diet difficult.

Multiple *IG* products are available both in stores and *via* the internet, and the included studies do not support one supplement over another. Quality and dosing of products may vary widely and make it difficult to direct patients to an effective dose. Although the initial results are promising for the use of *IG* in weight loss with few reported adverse effects, the long-term benefits and risks are currently unknown. Based on the available evidence, we would not recommend routine use of *IG* for weight loss in overweight or obese patients; however, for those patients wishing to take *IG* based on media reports, we would inform them of the available dosing information and potential adverse effects. Those who take *IG* should be monitored for weight loss, decreased waist circumference, decrease in total cholesterol and LDL cholesterol and lowered blood glucose as well as the development of insomnia, flatulence and headache.

IG is thought to contribute to weight loss *via* its effects as a bulk laxative and a decrease in adipongenesis. Further studies will need to be performed in order to fully describe the effects of *IG* on adipocytes and weight loss.

CONCLUSION

Irvingia gabonensis demonstrates potential for significant weight loss of up to 12 pounds in overweight and obese subjects over a period of 10 weeks with few reported adverse events. Larger studies including subjects from multiple countries for 6 to 12 months should be conducted to elucidate the long-term effects in various populations.

AUTHOR DISCLOSURE STATEMENT

No competing financial disclosures exist.

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