THE EFFECTS OF *Garcinia atroviridis (ASAM GELUGUR)* EXTRACTS ON BODY COMPOSITION IN RELATION TO WEIGHT MANAGEMENT: A SCOPING REVIEW

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ABSTRACT

Introduction: In developed countries, the extract of *G. atroviridis (*or locally known as *asam gelugor)* has been widely used as supplement for weight loss. Despite being found in abundance and used every day for food preparation, the awareness about the plant's anti-obesity effect is still low in Malaysia. Therefore, the main aim of this study was to identify the potential role of *Garcinia atroviridis* (or locally known as *asam gelugur*) in weight management by studying its effect on body composition (body mass index and waist circumference). The current study also intended to explore the functional dosage of *G. atroviridis* extracts required to alter body composition status. This study focused on two extracts of this fruit: hydroxycitric acid (HCA) and flavonoids. **Methods:** A scoping review was conducted to analyze the data found in five databases using these keywords: garcinia extract OR garcinia atroviridis OR garcinia Hydroxycitric acid OR HCA OR flavonoids AND body composition OR body mass index OR body weight OR waist circumference AND weight loss OR weight maintenance OR weight management OR weight OR anti-obesity NOT garcinia cambogia. The populations of intervention included in this study comprised of human and animal. A total of nine journals were finalised and mapped onto an evidence table. **Results:** From the review, the extracts of *G. atroviridis* appears to affect body composition status. The HCA extract should be consumed below 1000 mg/day to reduce bodyweight, but no data was found on flavonoids. In human, the dose of flavonoids should be lower than 500 mg. **Conclusions:** With the ingestion of appropriate amount, the *Garcinia atroviridis* extracts (HCA and flavonoids) might be helpful in managing weight. In future, further research can be conducted to determine the appropriate dosage of *G. atroviridis* for human consumption.

KEYWORDS: *Garcinia atroviridis,* body mass index, waist circumference, weight management

INTRODUCTION

Based on the World Health Organisation (WHO) statistics, more than 1.9 billion adults aged 18 years and older were overweight or obese in 2016. Locally, as reported by the National Health and Morbidity Survey (NHMS) 2015, there were 30% overweight and 17.7% obesity prevalence among Malaysian adults aged 18 years and above (Razak, 2015). In relation to this situation, there is a wide emergence of health products in the market which claimed to be promoting weight loss.

Garcinia is one of the ingredients used in natural weight loss supplements in the Western countries. In Europe and United States, *Garcinia atroviridis (asam gelugur)* is normally found in the form of weight loss supplement, in which mostly the ingredients consist of 50% to 70% extract of this plant. One *garcinia* species that is widely used is *G. cambogia.* This bright yellow fruit can be widely found all over Malaysia. Found abundantly in Perak, Kelantan, Terengganu, Kedah, Pahang and Negeri Sembilan, the edible part of this plant is its fruit which is round and shows folded-like physical textures. Once this fruit matures, the colour will turn from green into bright yellow.

There were very few studies on the effects of *G. atroviridis* on body composition in Malaysia. The effectiveness of this fruit on weight management was thus less acknowledged. Through scoping review method, this study aimed to review the effects of *G. atroviridis* extracts (hydroxycitric acid (HCA) and flavonoids) on body composition, body mass index (BMI) and waist circumference (WC). In addition, this review would also investigate the recommended doses of hydroxycitric acid (HCA) and flavonoids that are helpful for weight reduction.

METHODS

This scoping review was conducted using six-step process including setting the research question, sourcing studies, selecting studies, recording data, summarising results, and consulting on the findings (Tricco et.al, 2016). The current study followed a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2009 guidelines.

Databases and search keywords

Five databases were selected which included Scopus, Academic Search Premier, OVID LLW, CINAHL Plus, and Google Scholar. The search keywords used in the current study were:

-*garcinia* extract OR *garcinia atroviridis* OR *garcinia*
-Hydroxycitric acid OR HCA
-OR flavonoids
-AND body composition OR body mass index OR body weight OR waist circumference
-AND weight loss OR weight maintenance OR weight management OR weight OR anti-obesity
-NOT *garcinia cambogia*

Article Eligibility Criteria

The inclusion and exclusion criteria are presented in Table 1.

Table 1. Inclusion and exclusion criteria for this study review

Inclusion Criteria	Exclusion Criteria
• Adult male and female • Age 18 years old and above • Studies that were published in English language • Open access articles, free resources • Reliable and properly cited journals • Studies involved human and animal • Studies done from year 2000 onwards • Obesity-related study	• Children (<18 years old) • Juvenile diabetes • Non-English publication • Review papers • Studies done before 2000 • Articles (open access) that were promoting *garcinia* supplementation

Study Selection

There were four stages of selecting the most valid studies to be reviewed. The first stage was identification stage where the keywords were inserted in the advanced search box of each database. The results were screened in the next stage to identify

duplicated publications and to include the selected ones in the review. Studies were included by assessing the titles and abstracts against the inclusion and exclusion criteria. Once included, these studies underwent another stage where the eligibility of each of the studies were reviewed according to the nature and the aspect of this current study and assessed with reasons. The fourth stage was when the studies were finalised and included for qualitative synthesis. Assessment was made against the inclusion criteria. The obtained data were organized into tables created for animal, human, and laboratory studies, respectively.

RESULTS

Journals Screened Based on Five Databases

As demonstrated in Figure 1, a total of 371 journals were identified through five databases, with 105 data from Scopus, 77 from Academic Search Premier, 37 from CINAHL Plus, 94 from Google Scholar and 58 from OVID LLW. Then, 172 journals were removed due to duplication, leaving 199 journals. After going through the screening and eligibility stages, the total journals left were 54. Out of these, 27 studies were considered irrelevant. These included review papers (13), studies which were not comprehensive in which the authors failed to elaborate on the study design (2), a study which did not evaluate the extracts of *G. atroviridis* on body composition or weight management, and incomplete full text (1). Fourty-four journals were further removed due to ineligibility. At the end, a total of eight journals were included in this review.

The Effect of *G. atroviridis* Extracts on Body Composition: Animal Studies

Shara et al. (2004), Bagchi et al. (2006), Rao et al. (2009) and Najafian et al. (2010) conducted studies or investigations on animals, specifically rat of different species with various kind of study designs, including randomized controlled trials, placebo-control group, case-control study and lab-based investigation (Table 1). These studies had shown that the BMI and BW components of all the studied animals showed significant reduction.

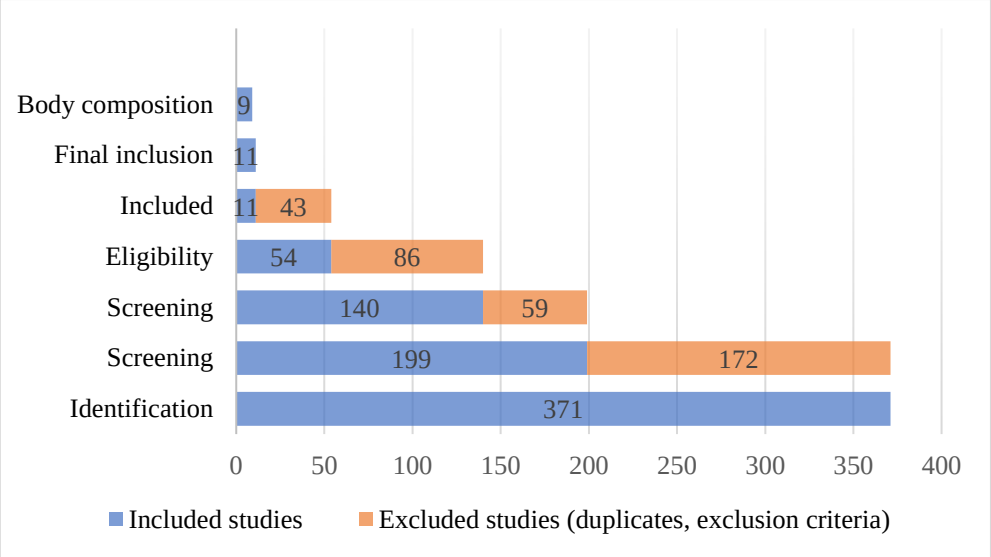

Figure 1. PRISMA flow bar chart

Shara et al. (2004) found that after 90 days of study, approximately 11.2, 18.1 and 15.8% reduction in body weights were observed in the intervention group (male rats) of 0.2, 2.0 and 5.0% HCA-SX as compared to the corresponding control (Table 2). Approximately 11.7, 12.4 and 13.0% reduction in body weights were observed in female rats as compared to the corresponding control group. Bagchi et al. (2006) conducted a study on HCA extract towards 8-week old Sprague-Dawley rats for eight weeks. During the first six weeks, there was a significant decrease in body weight of the 10 mg/kg body weight HCA-SX fed rats compared to the placebo-fed group. After that, in the next two weeks, the difference in the body weight of the intervention group was held steady.

Rao et al. (2009), on the other hand, found that the average weight gained in an eight-week period by rats in the control group (9.9 ± 3.3 g) to be higher than in the intervention group (HCA 1.1 mmol/kg/day -5.2 ± 2.54 g, HCA 3.7 mmol/kg/day -2.2 ± 0.9 g, and HCA 5.5 mmol/kg/day -10.5 ± 1.9 g). In Najafian et al. (2010) study, the rats were comprised of diabetic rats (DR) and non-diabetic rats (NDR) for both control and intervention groups. The intervention group received different dosage of trans-chalcone (Tc, an open-chained flavonoid which inhibits the action of fatty acid synthase and α-amylase) at 2, 8, 16, 32 mg/kg dissolved in grape seed oil. It was found that the body weight of DR was significantly reduced as compared to NDR (206.3±13.1 vs. 245.1±15.8, $P<0.01$). Meanwhile, Tc was found to induce weight loss in both NDTc (190 g) and DTc rats (240 g). Weight loss in DTc8 (188 g), DTc16 (188 g) and DTc32 (180 g) were also significantly lower than both NDR (240 g) and DR (210 g).

Table 2. The effect of G. atroviridis extracts on body composition (animal studies)

Study	Author	Population & no. of intervention	Extracts & doses	BMI/Body Weight	WC
1	Shara et al. (2004)	Sprague-Dawley rats (Control – 7, intervention – 7)	**(Intervention)** HCA-SX was given at 0.2%, 2.0% and 5.0% of feed intake **(Control)** -provided with 0% HCA-SX -received only water	↓	-
2	Bagchi et al. (2006)	Sprague-Dawley rats (Control – 25, intervention – 25)	**(Intervention)** 10 mg/kg BW of HCA-SX dissolved in water **(Control)** No supplementation	↓	-
3	Rao et al. (2009)	Wistar albino strain rats (Control – 24 rats, intervention – 18 rats)	**(Intervention)** HCA trisodium salt + HCAL aqueous solution at 1.1, 3.7, 5.5 mmol/kg/day **(Control)** Standard rodent diet	↓	-
4	Najafian et al. (2010)	Wistar rats (no information, rats were divided into groups of diabetic rats, DR and non-diabetic rats, NDR)	**(Intervention)** NDR & DR: given trans-chalcone (flavonoids derivative) at 2, 8, 16, 32 mg/kg dissolved in grape seed oil **(Control)** NDR & DR: received grape seed oil	↓	-

BMI – Body mass index; WC – Waist circumference

The Effect of *G. atroviridis* Extracts on Body Composition: Human Studies

In human studies on the effect of *G. atroviridis* extracts on body composition (Table 2), all four studies showed significant body weight reduction. However, only Lumbantobing et al. (2017), Mattes et al. (2000) and Syukur et al. (2017) displayed significant reduction in WC.

Mattes et al. (2000) did a 12-week study on 18 to 65 years old overweight women, where the result demonstrated that the mean weight loss was 3.7 ± 3.1 kg (intervention group) which was significantly higher than the control group's (2.4 ± 2.9 kg). Both groups showed statistically significant reduction (t=2.26, p=0.026) for WC.

Although both groups reported to lose weight over study period, the intervention group achieved significantly greater reduction. There were earlier reports which suggested that the efficacy of HCA was not ascribed alone but with the combination with chromium (HCA + chromium). In addition, more consistent weight loss was reported with the ingestion of lower doses of HCA (750 mg/day) compared to higher doses, for example: 1300-1500 mg/day.

Roongpisuthipong et al. (2007) conducted a study where the participants in the intervention group were required to take one HCA sachet before meals, thrice every day. The sachet was dissolved in 200ml of water. At the same time, the control group received a placebo sachet that was also prescribed thrice daily. All the study participants were restricted into the same diet regime; 1000 kcal energy per day with carbohydrates distribution (125 g), protein (50 g) and fat (33 g). The means of BW and BMI of the intervention group at week four and eight decreased significantly from week 0, whereas as later as week eight, the control group showed significant decrease from week 0. At week 8, the body weights of participants in the intervention group showed a significant reduction of 2.8 ± 0.1 kg, more than the weights of the control participants (1.4 ± 0.1 kg). The BMI of the intervention group also showed a higher reduction (0.9 ± 0.2 kg/m^2), as compared to the control group (0.6 ± 0.2 kg/m^2). However, there were no changes in WC of both groups.

Table 2. The effect of G. atroviridis extracts on body composition (human studies)

Study	Author	Population & no. of intervention	Extracts & doses	BMI/ BW	WC
5	Mattes et al. (2000)	Overweight women (Control – 25, intervention – 25)	**(Intervention)** HCA dose: 1.2 g/day **(Control)** Placebo sachet of the same dose	↓	↓
6	Roongpisuthipong et al. (2007)	Obese women (Control – 25, intervention – 25)	**(Intervention)** HCA sachet contains 1.15g *G. atroviridis.* Dissolve sachet in 200ml of water **(Control)**	↓	Unchanged

7	Syukur et al. (2017)	Obese human (Intervention – 15)	Placebo sachet dissolves in 200ml of water **(Intervention)** *G. atroviridis* tea brewed in 200ml of water	↓	↓
8	Lumbantobing et al. (2017)	Obese human (Control – 10 male, 5 female. Intervention – 4 male, 11 female)	**(Intervention)** Given one sachet of *G. atroviridis* leaf tea brewed in 200 ml of boiled water at 100^{o}C **(Control)** No tea given	↓	↓

BMI – Body mass index; WC – Waist circumference

The study done by Syukur et al. (2017) demonstrated different outcomes of BMI according to gender. The mean BMI value of males was reduced from 29.84 ± 3.16 to 29.04 ± 3.14 kg/m2. Whereas for female, the mean BMI reduced from 34.28 ± 1.99 kg/m2 to 33.78 ± 1.94 kg/m2. In addition, the WC measurement in male was reduced from 104. 90 ± 8.12 cm to 103.70 ± 7.56 cm. Among females, the mean WC was reduced from 103.00 ± 6.36 cm to 101.20 ± 6.22 cm. The reduction of both BMI and WC measurements were statistically significant.

These showed that men experienced greater reduction in BMI and WC as compared to women. The same finding was obtained from an animal study by Shara et al. (2004) in which male rats were found to show significantly greater body weights reduction upon the ingestion of HCA-SX as compared to the females. The gender role was explained by Bhogal et al. (2014). Men tend to lose more weight than women when engaging with weight loss intervention because mMen normally have higher starting weight than women, which explained the larger weight loss at differing time scales. In addition, males also have more lean muscle tissue, which burns more calories even during resting (Barnett, 2017).

Another human study (Lumbantobing et al.,2017) demonstrated that after four weeks of intervention, the BMI was reduced more in the intervention group (from 31.32 ± 3.49 to 30.85 ± 3.46 kg/m2) who consumed one sachet of G. atroviridis brewed as tea daily compared to the control group (from 32.60 ± 4.64 kg/m2 to 31.82 ± 4.80

kg/m2) who did not. The mean WC declined from 104 ± 7.23 cm to 102.07 ± 7.43 cm in control group and 104.27 ± 7.40 cm to 102.87 ± 7.02 cm in study group.

DISCUSSION

This study aimed to investigate the effects of *G. atroviridis* extracts on body composition (BW, BMI and WC) in relation to weight management In addition, it also intended to identify the extracts inside *G. atroviridis* that have anti-obesity effect, and to determine the recommended doses of hydroxycitric acid (HCA) and flavonoids that are helpful in losing weight.

The investigation upon *G. atroviridis* extracts on body composition (BW, BMI, WC) revealed that the ingestion of these extracts significantly reduced all these three components except for a study by Roongpisuthipong et al. (2007) where the WC remained unchanged. Dosage of the extracts contributed to a huge part of their efficacies. This is due to the result yield by Najafian et al. (2010) in which the diabetic and non-diabetic rats showed greatest body weight reduction when ingested 32 mg/kg doses of trans-chalcone (open-chained flavonoids). Therefore, the dosage of flavonoids played significant role on the effectiveness of it towards weight reduction. At present, there is no definite recommendation on flavonoids for human intake as studies about this extract are still ongoing.

However, higher intensity of the dosage did not simply imply effectiveness. Given the low dosage of 10 mg/kg resulted in higher weight reduction in animals (rats) (Bagchi et al., 2006). In fact, higher doses may cause ineffectiveness of substances. Although not exerting toxicity effect, overdosage may lead to altered activities of enzymes, as evidenced by the study done by Koshy et al. (2001). This author supported her argument by pointing out evidence by a recent report of human study on quercetin (plant pigment flavonoids) supplementation and demonstrated that supplementation with 2.8 g/day quercetin was ineffective. 2.8 g dosage is considered high for flavonoids. This was why most studies conducted their research by using dosage of below 500 mg per day.

This study aimed to assess the findings on the G. atroviridis extracts: HCA and flavonoids. However, studies that investigated the flavonoids effect on body composition were very limited. Thus, not much discussion could be done on flavonoids and its potential effects on weight management. In addition, some studies were conducted to compare the effects of certain Garcinia commercial products, as opposed to using it as a natural ingredient in the research.

More studies regarding G. atroviridis in relation to weight management would be useful such as randomized controlled trials. This is because human study is lacking in Malaysia, especially for this plant. Other than that, researchers can focus on the mechanisms behind the actions of HCA and flavonoids that help in reducing body weight and normalised biochemical profile values. In addition, research investigating the effective doses of the G. atroviridis extracts to reduce weight is also needed.

CONCLUSION

There is evidence that *G. atroviridis* extracts namely hydroxycitric acid and flavonoids may be helpful to reduce body composition. Although not all studies yielded the same result for every component, the overview suggested that this fruit has a promising effect for controlling body composition. The dosage plays an important role. However, it still depends on the users' age and health conditions (Bunchorntavakul et al., 2013). For HCA, the recommended intake to decrease weight according is of lower dosage (below 1000 mg/day) but no definite amount could be determined for flavonoids.

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