Beneficial Effects of Golden Kiwifruit Consumption in Overweight and Obese Young Adults

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Summary Overweight and obesity are associated with many chronic diseases. This study aimed to clarify the possible effects of consuming golden kiwifruit as daily fruit intake on body composition, lipid metabolism and inflammatory responses. Methods: We recruited twenty-two overweight and obese subjects and they were asked to consume two golden kiwifruit every day during the 6-wk experimental period. At the baseline and end of the study, fasting blood samples were collected and anthropometric and blood pressure measurement were conducted. Results: During the experimental period, no adverse effect and dropout were reported. At the end of the study, a significant decrease in body fat and circulatory tumor necrosis factor (TNF)-α concentration were found. In addition, there was a reduction of angiotensin II (AgII) concentration and systolic blood pressure in subjects with baseline systolic blood pressure (SBP) ≥ 125 mmHg. Conclusion: Our results suggested that daily golden kiwifruit intake can reduce body fat mass, improve blood pressure and regulating inflammatory responses in overweight and obese young adults.

Key Words kiwi, overweight, lipid, blood pressure, inflammation

Overweight and obesity are associated with various health problems. Excessive energy intake and imbalanced dietary intake resulted in abdominal fat accumulation and increased risk in metabolic disorders such as dyslipidemia, insulin resistance and increase of chronic inflammatory response, which are reported to be strongly linked to metabolic syndrome, diabetes and cardiovascular diseases (1, 2). Therefore, strategies to promote better dietary habits become an important issue nowadays. Although fruit and vegetable intake are reported to be beneficial to decreased risks of chronic diseases and obesity, most people do not consume enough fruits and vegetables to meet the guidelines (3, 4). Recent Nutrition and Health Survey in Taiwan (NAHSIT) also reported that more than 85% of the population in Taiwan consumed fruit below the recommended servings.

Kiwifruits are good dietary source of plant-derived phytochemicals and antioxidants. Previous studies reported that Actinidia species contains various flavonoids and showed antioxidantive activities (5, 6). Daily consumption of two kiwi fruits for 4 wk improved anti-oxidative capacity in subjects with hyperlipidemia (7). Actinidia chinensis, which is also known as golden kiwifruit, contains 161 mg vitamin C per 100 g flesh and is also rich in vitamin E, potassium and dietary fiber (8). A cross-sectional study also showed that consumption of kiwifruit per week may be related to improvement of blood lipid profiles and lower cardiovascular risks (9).

However, studies of the effects of golden kiwifruit consumption on metabolic parameters in human are still limited. Thus, the aim of the study was to clarify the possible effects of consuming golden kiwifruit as daily fruit intake on body composition, lipid metabolism and inflammatory responses in overweight and obese young adults.

MATERIALS AND METHODS

Subjects. Twenty-two subjects with body mass index (BMI) ranging from 25 to 35 and waist circumference more than 90 cm for men and 80 cm for women were recruited. The subjects were recruited by announcement posters at I-Shou University (Kaohsiung, Taiwan). The exclusion criteria were as follows: diabetes; cardiovascular diseases; eating disorders; liver, kidney and other digestive diseases; medications and supplement users; women under pregnancy or lactation; allergy to kiwifruits. The purpose, design and possible risks of this study were explained to all participants, and written informed consents were received from all participants.

Experimental design. The study was conducted in following the protocol approved by the Institutional Review Board of E-Da Hospital according to the guidelines in the Declaration of Helsinki (IRB No.: EMRP-106-024). During the 4-wk experimental period, participants were asked to consume 2 golden kiwifruits (Zespri SunGold Jumbo, 146–175 g/each) per day as their daily fruit intake. The participant came to the center weekly to obtain kiwifruits and receive dietary consultation from a dietitian. The consumption of other supplements and functional food were prohibited.
During the experimental period, participants were asked to maintain their food intake and were also asked to do 3-d food record. Dietary composition was evaluated using nutrient analysis software (E-Kitchen, Taichung, Taiwan).

**Blood pressure measurement.** The participants visited the research center at 07:30 in the morning at the baseline and end of the study in at least 8 h of fasting condition. After 10 min rest, systolic and diastolic blood pressure were measured on the right arm with an automatic blood pressure monitor (Microlife, Taipei, Taiwan). Systolic blood pressure (SBP) was calculated as the average of three measurements.

**Anthropometric measurements.** After blood pressure measurement, body weight, height, waist and hip circumference of subjects were measured to calculate body mass index (BMI) and waist-hip ratio (WHR). Triceps skinfold (TSF) was measured by a trained assistant using calipers and body composition was measured by the bioimpedance analysis method (TFB-410GS Body Composition Analyzer, IL, US).

**Blood analysis.** Participants’ blood samples were collected at the baseline and end of the study after at least 8-h fasting. Biochemical analyses included blood glucose (BS), total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), aspartate transaminase (AST), alanine transaminase (ALT), HbA1c and C-peptide were carried out on Hitachi 7170 Autoanalyzer (Hitachi, Tokyo, Japan). Malondialdehyde (MDA) concentration was measured using thiobarbituric acid reactive substance (TBARS) method as according to the previous report (10). Antioxidant capacity was measured using colorimetric method by ferric reducing antioxidant power (FRAP) assay kit (Biovision, CA, US). Circulatory tumor necrosis factor (TNF)-α, interleukine (IL)-6, angiotensin II (AgII), leptin and adiponectin concentrations were determined using enzyme-linked immunosorbent assay (ELISA) kits (TNF alpha & IL-6 Human ELISA kit, high sensitivity, Invitrogen, CA, US; Angiotensin II and leptin Human ELISA, Biovendor, Brno, Czech Republic; Human Adiponectin ELISA kit, MO, US).

**Statistical analysis.** All data are presented as Mean ± SEM. The results of dietary, anthropometric, blood pressure and biochemical analysis of the baseline and end of the study for each subject were evaluated by the paired t-test. Differences with a p value <0.05 were considered to be statistically significant.

**RESULTS**

Twenty-two overweight or obesity students were recruited in this study, consisted of 10 males and 12 females with an average age of 21.9±0.3 y old. The average body weight and BMI at week 0 were 80.7±2.4 kg and 29.2±0.8, respectively. Table 1 shows the results of the diet analysis before and after the intervention of golden kiwifruit. At week 6, daily total calorie intake was significantly higher than week 0, which was about 250 calories. Since we asked subjects to take an additional 2 kiwifruits per day without changing usual dietary habits in this study, it was considered that most of the additional calories were from the intake of kiwifruit (8). No significant differences were found in the percentage of energy derived from carbohydrate, protein and lipid. In addition, the supplementation of golden kiwifruit significantly increased daily intake of dietary fiber, vitamin C, vitamin E, Ca and Mg.

After our 6-wk golden kiwifruit intervention, anthropometric changes were shown in Table 2. There was no significant change in body weight and BMI, while body fat mass was significantly decreased (from 37.04% to 35.83%, p=0.002). In addition, there was also a downward trend of waist and hip circumference. Although there was no significant decrease in SBP after the 6 wk of intervention, in the subgroup with baseline SBP beyond 125 mmHg, SBP significantly reduce from 132 mmHg to 125 mmHg (p=0.031). These results showed that the golden kiwifruit intake significantly improved body composition and had a positive regulatory effect on blood pressure in obese or overweight populations categorized as prehypertension.

At the end of the study, there were no significant changes in serum fasting glucose, HbA1C, blood lipids (Table 3). There were also no differences in AST, ALT, MDA and FRAP at the end of the study. In serum cyto-

| Week 0 | Week 6 | p value |
|--------|--------|---------|
| Total energy (kcal) | 1,538.0±62.9 | 1,790.3±87.6 | 0.012 |
| Carbohydrate (%) | 51.0±1.2 | 51.1±1.1 | 0.963 |
| Lipid (%) | 33.8±1.0 | 34.5±1.00 | 0.592 |
| Protein (%) | 15.2±0.5 | 14.4±0.5 | 0.206 |
| Dietary fiber (g) | 7.4±0.6 | 11.6±0.8 | <0.001 |
| Vit C (mg) | 52.1±5.2 | 193.0±0.3 | <0.001 |
| Vit E (mg α-TE) | 5.3±0.3 | 10.6±5.3 | <0.001 |
| K (mg) | 1,276.3±69.0 | 1,335.2±62.8 | 0.486 |
| Ca (mg) | 251.7±21.6 | 337.0±30.8 | 0.007 |
| Mg (mg) | 138.8±7.0 | 160.5±8.9 | 0.021 |

Values are presented as the mean±SEM (n=22).
The differences after the 6-wk intervention.

In analyses of adipokines, plasma leptin, and adiponectin concentrations, there were no significant differences after the 6-wk intervention.

**DISCUSSION**

Golden kiwifruit is a recently popular fruit with yellow flesh and rich in various nutrients and phytochemicals (5). However, studies about its effects on metabolic disorders remain very few. In the present study, we found that daily consumption of two golden kiwifruits were acceptable and able to decrease fat mass in overweight and obese subjects with baseline BMI ranging from 24.7 to 40.4. Although the additional 2 kiwifruit supplementation resulted in mild increase of total energy intake, we found no significant change in body weight and BMI after 6-wk intervention. No subject reported any adverse effect or dropout during the experimental period. These results suggested that golden kiwifruit can be considered as a beneficial source of fruit choice in the meal pattern for overweight and obese people.

Obesity leads to low-grade inflammation and it is related to the progression of many chronic diseases. In 1993, Hotamisligil et al. reported an elevation of TNF-α expression in obese rodents and its relation with insulin resistance (11). Imbalance adipokine secretion and activation of various inflammatory signaling pathways are associated with the increase of proinflammatory parameters and abnormal metabolic outcomes (12), thus proper management of inflammation state, oxidative stress and energy balance play a crucial role in health (13). In the present study, we found that daily consumption of golden kiwifruit significantly decreased circulating TNF-α and had a trend to reduce IL-6. Recent data revealed that overnutrition is related to the increase of TNF-α and IL-6 concentration, and this may interfere normal metabolic processes and lead to diabetes (14).

Dietary supplementation with phytochemicals exhibited anti-oxidative or anti-inflammatory potentials is beneficial to ameliorate obesity and related metabolic disorders (15). Supplemented diet with 1% ascorbic acid can also alleviate visceral and hepatic fat accumulation and reduce inflammation in mice fed a high-fat diet (16). Our results suggested that golden kiwifruit may have protective effects in obesity-related inflammation.

High blood pressure is related to the progression of many chronic diseases (17). According to the blood-pressure categories published in the 2017 American...
College of Cardiology/American Heart Association (ACC/AHA) hypertension guideline, they reduced the threshold for hypertension diagnosis because populations with SBP beyond the defined normal range have higher risks of cardiovascular diseases. In the present study, we found that 6-wk regular consumption of golden kiwifruit significantly decreased SBP as well as circulating Ag II level in subjects with higher baseline SBP. Although kiwifruit was reported to be one of the foods with antihypertensive potentials (18), no direct evidence on the effects of kiwifruit intake on blood pressure management was found. Renin-angiotensin system plays an important role in regulating blood pressure in vivo. Angiotensin-converting enzyme (ACE) stimulates the production of Ag II, an active peptide which leads to vasoconstriction and elevation of blood pressure. Recent studies demonstrated that white adipose tissue can also secrete angiotensin, especially in obese subjects (19), and resulted in the elevation of angiotensin II level and blood pressure, and further induced the secretion of proinflammatory cytokines such as TNFα, IL-1β and IL-6 (20). Some plant-derived polyphenols and flavonoids were reported to have ACE inhibitory activities (21). Antioxidative vitamins and polyphenols were also shown to improve vascular inflammation and endothelial dysfunction cardiovascular diseases (22). In addition, the decrease of proinflammatory cytokine TNF-α was reported to be a target to ameliorate low-grade inflammation in hypertension (23). Our results suggested that addition golden kiwifruit in daily diet might be beneficial for blood pressure management in hypertensive population, but the underlying mechanisms needs to be further studied.

Daily consumption of two golden kiwifruits significantly increased daily dietary fiber intake in subjects. Many studies reported that dietary fibers can help improving blood lipid profile and regulating blood glucose (24). However, we found no significant decrease in fasting glucose and blood lipids in subjects at the end of this study. One of the reasons may be the baseline blood glucose and blood lipid concentrations of our subjects were within normal range. In addition, our subjects still did not have sufficient daily dietary fiber intake as previously instructed in the experimental period. Previous cross-sectional study showed that regular kiwifruit consumption is associated with better lipid profile (9). A study in healthy subjects also showed that golden kiwifruits had stronger antioxidative effects than green one in vivo (25). However, there were still several limitations of this study. The sample size was small and we were not able to offer meals to subjects to confirm the exclusion of all possible dietary-interfering factors. This study offers a preliminary data about the effects of golden kiwifruit in overweight and obese adults. Future studies may focus on the application of golden kiwifruit consumption in subjects with risks of metabolic syndrome, such as hyperlipidemia and insulin resistance.

In conclusion, daily consumption of golden kiwifruit for 6 wk can contribute in reduced body fat mass and blood pressure, reduction, and regulation of inflammatory responses in overweight and obese young adults. The results of this study may be useful for diet management and suggestions for overweight populations.

Disclosure of state of COI
All authors stated that there were no conflicts of interest.

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REFERENCES
1) Schetz M, De Jong A, Deane AM, Druml W, Hemelaar P, Pelosi P, Pickkers P, Reintam-Blaser A, Roberts J, Sakr Y, Jaber S. 2019. Obesity in the critically ill: a narrative review. Intensive Care Med 45: 757–769.
2) Ortega-Loubon C, Fernandez-Molina M, Singh G, Correa R. 2019. Obesity and its cardiovascular effects. Diabetes Metab Res Rev 35: e3135.
3) Wagner MG, Rhee Y, Honrath K, Blodgett Salafia EH, Terbizan D. 2016. Nutrition education effective in increasing fruit and vegetable consumption among overweight and obese adults. Appetite 100: 94–101.
4) Castro-Barquero S, Lamuella-Raventos RM, Domenech M, Estruch R. 2018. Relationship between Mediterranean dietary polyphenol intake and obesity. Nutrients 10: 1523.
5) Ma T, Sun X, Zhao J, You Y, Lei Y, Gao G, Zhan J. 2017. Nutrient compositions and antioxidant capacity of kiwifruit (Actinidia) and their relationship with flesh color and commercial value. Food Chem 218: 294–304.
6) Fiorentino A, D’Abrosca B, Pacifico S, Mastellone C, Scognamiglio M, Monaco P. 2009. Identification and assessment of antioxidant capacity of phytochemicals from kiwi fruits. J Agric Food Chem 57: 4148–4155.
7) Chang WH, Liu JP. 2009. Effects of kiwifruit consumption on serum lipid profiles and antioxidative status in hyperlipidemic subjects. Int J Food Sci Nutr 60: 709–716.
8) Sivakumaran S, Huffman L, Sivakumaran S, Drummond L. 2018. The nutritional composition of Zespri® SunGold Kiwifruit and Zespri® Sweet Green Kiwifruit. Food Chem 238: 195–202.
9) Recio-Rodriguez JL, Gomez-Marcos MA, Patino-Alonso MC, Puigdomenech E, Notario-Pacheco B, Mendizabal-Gallastegui N, de la Fuente Ade L, Otegui-Harduya L, Madrueño-Fernandez JA, de Cabo Laso A, Agudo-Conde C, Garcia-Ortiz L, Group E. 2015. Effects of kiwi consumption on plasma lipids, fibrinogen and insulin resistance in the context of a normal diet. Nutr J 14: 97.
10) Griesmacher A, Kindhauser M, Andert SE, Schreiner W, Toma C, Knoebel P, Pietschmann P, Prager R, Schnack C, Scherthaner G, et al. 1995. Enhanced serum levels of thiobarbituric-acid-reactive substances in diabetes mellitus. Am J Med 98: 469–475.
11) Hotamisligil GS, Shargill NS, Spiegelman BM. 1993. Adipose expression of tumor necrosis factor-alpha: direct role in obesity-linked insulin resistance. Science 259: 87–91.
12) Hotamisligil GS. 2006. Inflammation and metabolic dis-
orders. Nature 444: 860–867.

13) Hotamisligil GS. 2017. Inflammation, metaflammation and immunometabolic disorders. Nature 542: 177–185.

14) Dandona P, Alijada A, Bandypadhyay A. 2004. Inflammation: the link between insulin resistance, obesity and diabetes. Trends Immunol 25: 4–7.

15) Yang HY, Yang SC, Chiao JC, Chen JR. 2012. Beneficial effects of catechin-rich green tea and inulin on the body composition of overweight adults. Br J Nutr 107: 749–754.

16) Lee H, Ahn J, Shin SS, Yoon M. 2019. Ascorbic acid inhibits visceral obesity and nonalcoholic fatty liver disease by activating peroxisome proliferator-activated receptor alpha in high-fat-diet-fed C57BL/6j mice. Int J Obes (Lond) 43: 1620–1630.

17) Lee JH, Kim SH, Kang SH, Cho JH, Cho Y, Oh IY, Yoon CH, Lee HY, Youn TJ, Chae IH, Kim CH. 2018. Blood pressure control and cardiovascular outcomes: Real-world implications of the 2017 ACC/AHA Hypertension Guideline. Sci Rep 8: 13155.

18) Zou P. 2016. Traditional Chinese medicine, food therapy, and hypertension control: A narrative review of Chinese literature. Am J Chin Med 44: 1579–1594.

19) Van Harmelen V, Ariapart P, Hoffstedt J, Lundkvist I, Bringman S, Arner P. 2000. Increased adipose angiotensinogen gene expression in human obesity. Obes Res 8: 337–341.

20) Kalupahana NS, Moustaid-Moussa N. 2012. The renin-angiotensin system: a link between obesity, inflammation and insulin resistance. Obes Rev 13: 136–149.

21) Adelegba SA. 2018. Functional foods and nutraceuticals as dietary intervention in chronic diseases: Novel perspectives for health promotion and disease prevention. J Diet Suppl 15: 1–10.

22) Siti HN, Kamisah Y, Kamsiah J. 2015. The role of oxidative stress, antioxidants and vascular inflammation in cardiovascular disease (a review). Vascul Pharmacol 71: 40–56.

23) Mehaffey E, Majid DSA. 2017. Tumor necrosis factor-alpha, kidney function, and hypertension. Am J Physiol Renal Physiol 313: F1005–F1008.

24) Fuller S, Beck E, Salman H, Tapsell L. 2016. New Horizons for the Study of Dietary Fiber and Health: A Review. Plant Foods Hum Nutr 71: 1–12.

25) Iwasawa H, Morita E, Yui S, Yamazaki M. 2011. Antioxidant effects of kiwi fruit in vitro and in vivo. Biol Pharm Bull 34: 128–134.