Review Article

Effectiveness of traditional Malaysian vegetables (*ulam*) in modulating blood glucose levels

Mohd Faez Bachok BSc[1], Barakatun-Nisak Mohd Yusof PhD[1], Amin Ismail PhD[1], Azizah Abdul Hamid PhD[2]

[1]*Department of Nutrition and Dietetics, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia*
[2]*Department of Food Science, Faculty of Food Science and Technology, Universiti Putra Malaysia, Serdang, Selangor, Malaysia*

Ulam refers to a group of traditional Malaysian plants commonly consumed as a part of a meal, either in the raw form or after a short blanching process. Many types of *ulam* are thought to possess blood glucose-lowering properties, but relatively little is known on the effectiveness of *ulam* in modulating blood glucose levels in humans. This review aims to systematically evaluate the effectiveness of *ulam* in modulating blood glucose levels in humans. A literature review was conducted using multiple databases with no time restriction. Eleven studies were retrieved based on *a priori* inclusion and exclusion criteria. In these 11 studies, only *Momordica charantia,* locally known as "peria katak", was extensively studied, followed by *Centella asiatica,* locally known as "daun pegaga", and *Alternanthera sessilis,* locally known as "kermak putih". Of the 11 studies, 9 evaluated the effectiveness of *M. charantia* on blood glucose parameters, and 7 of which showed significant improvement in at least one parameter of blood glucose concentration. The remaining 2 studies reported nonsignificant improvements in blood glucose parameters, despite having high-quality study design according to Jadad scale. None of the studies related to *C. asiatica* and *A. sessilis* showed significant improvement in blood glucose-related parameters. Current clinical evidence does not support the popular claim that *ulam* has glucose-lowering effects, not even for *M. charantia.* Hence, further clinical investigation is needed to verify the glucose modulation effect of *M. charantia*, *C. asiatica*, and *A. sessilis*.

Key Words: medicinal plants, complementary therapy, diabetes mellitus, blood glucose, clinical trial

INTRODUCTION

Malaysia is a tropical country that contains various types of flora and fauna due to year-round high rains, hot temperature and high humidity. The climate facilitates the growth of many species of plants, among which exists a group of traditional Malaysian vegetables known as *ulam. Ulam* vegetables are consumed in a raw or boiled form and are usually eaten with rice-based meals.[1] *Ulam* is defined as "fresh green salad tossed in a blend of fermented sauces, aromatic herbs or spices eaten by Malays as side dishes with rice".[2] The tasty and flavour encourages its consumption not only among the Malay but also among other ethnic groups such as the Chinese and Indians.[3] In addition, *ulam* has potential as a functional food in view of its purported significant therapeutic and nutritional benefits. Nutritional studies have shown that many of these *ulam* vegetables are rich in carbohydrates, proteins, minerals and vitamins.[4-7] Certain *ulam* vegetables are also thought to have medicinal effects such as controlling blood pressure and blood glucose concentrations among patients with diabetes.[4]

The use of *ulam* as medicinal remedies by the public, including patients with diabetes, is common in many societies.[4] However, relatively little is known about the effectiveness of *ulam* in improving blood glucose concentrations and few *ulam* vegetables have been clinically tested in humans.[8,9] Previous studies have summarized the available evidence on the effectiveness of other types of plants, such as American Ginseng, on blood glucose level.[10-12] However, none of these studies focused on *ulam*, resulting in limited evidence-based conclusions of the effects of *ulam* on blood glucose levels. Given the increasing worldwide prevalence of diabetes, identifying high-quality evidence on the efficacy of *ulam* in the modulation of blood glucose levels is needed. Therefore, this review aimed to evaluate the effectiveness of traditional Malaysian vegetables or *ulam* in the modulation of blood glucose levels.

MATERIALS AND METHODS

A literature search on multiple databases using the key-

Corresponding Author: Dr Barakatun-Nisak Mohd Yusof, Department of Nutrition and Dietetics, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.
Tel: +603-89472524; Fax: +603-89426769
Email: bnisak@upm.edu.my
Manuscript received 07 July 2013. Initial review completed 07 August 2013. Revision accepted 02 February 2014.
doi: 10.6133/apjcn.2014.23.3.01

words "*ulam* and Malaysia" did not produce any related papers. Hence, we modified the method to identify papers related to *ulam* and blood glucose parameters. A total of 32 *ulam* vegetables were identified based on a list of popular *ulam* vegetables in Malaysia (Table 1). A subsequent search was conducted using multiple databases (MEDLINE, CINAHL, Cochrane, Wiley Online Library and Scopus) under search database of medical subjects heading (MeSH) terms "hypoglycemic effect", "blood glucose level(s)", "anti-diabetic" and "diabetes mellitus" together with the scientific name of *ulam* (Figure 2). The same searching procedure was repeated using Google Scholar to ensure all relevant published studies that were not listed by ISI were also included (Figure 1). The literature search was limited to articles published in Malay and English without time limitations. We included papers that evaluated improvement in blood glucose concentrations as assessed by reduced fasting or postprandial blood glucose and glycosylated haemoglobin A1c (HBA1c) concentrations. All identified published studies were reviewed by the first and second authors.

Studies included in this review involved healthy subjects and patients with diabetes or impaired glucose tolerance and were conducted according to one of the following study designs: clinical trials (controlled and randomized controlled), prospective observational studies, cross-sectional observational studies, or case-control studies. Studies were excluded if they were review papers, in vitro studies or conducted in animal models and or if they were not conducted according to one of the study designs previously listed. If the study was a randomized controlled trial, the quality of the study was assessed by criteria based on the Jadad scale[14] with scores ranging from 0 to 5 (5 indicated the highest quality research). This scale scores studied based on randomization, blinding, and an account of all subjects.[14]

An initial database search found a total of 55 studies evaluated *ulam* and the modulation of blood glucose. Various types of *ulam* were tested, including *Alternanthera sessilis* (kermak putih; n=2), *Anarcadium occidentale* (daun gajus; n=4), *Carica papaya* (daun betik; n=4), *Centella asiatica* (daun pegaga; n=3), *Cosmos caudatus* (daun ulam raja; n=1), *Momordica charantia* (peria katak; n=32), *Moringo oleifera* (daun kelor; n=1), *Parkia speciosa* (petai papan; n=1), *Piper sormentasum* (daun kaduk; n=1), *Pithecellobium jiringa* (buah jering; n=2) and *Psidium guajava* (daun jambu, n=4).

RESULTS

After excluding in vitro and animal studies, the literature search identified 11 studies that investigated 3 species of *ulam*, *M. charantia* or known as "peria katak", *C. asiatica* known as "daun pegaga" and *A. sessilis* known as "kermak putih". A total of 321 subjects were studied in 9 studies among diabetics,[8,9,15-20,22] one study among healthy subjects[23] and one study on both diabetics and healthy subjects.[21]

Of the 11 included studies, only 3 were randomized controlled trials involving *M. charantia*[8,9] and *C. asiatica*.[15] Based on the Jadad scale assessment, 2 of these studies,[8,9] had a score of >3, indicating high quality evaluation, while the remaining one study was categorized as a poor quality study.[15] In terms of blood glucose-related parameters, all 3 studies measured fasting blood glucose concentration,[8,9,15] and one each also measured postprandial blood glucose[9] and HbA1c.[15] Three other studies were controlled trials,[16-18] and the remaining 5 studies were case-series.[19,20-23] The characteristics and outcomes of all studies, including number of subjects and the study design are shown in Table 2.

Momordica charantia known as peria katak

Nine studies evaluated the effect of *M. charantia* (peria katak) intervention on fasting or postprandial blood glucose concentrations. Most of the earlier publications were mainly conducted in India.[16-18,21] Studies conducted between 1970 and 1990 were mainly performed as case-series and controlled trial studies, all of which reported significant reduction in postprandial or fasting blood glucose concentration following treatment with the evaluated *ulam*. However, studies after 2000 were randomized controlled trials, thereby providing more convincing evidence.[8,9] In one of these studies, despite properly being designed, neither fasting blood glucose nor HbA1c levels significantly improved after *M. charantia* therapy.[8] However, in another randomized controlled trial, Lim and Jimeno (2010)[9] found a significant reduction in postprandial blood glucose 15 mins after consumption of the highest dosage of *M. charantia* (100 mg/kg/day) extract in the form of tablet using a dose-dependent study design (i.e. 60 mg/kg/day and 80 mg/kg/day). This result may be due

Table 1. List of popular *ulam* vegetables in Malaysia[13]

1.	Buluh (rebung)-*Bambusa sp.*
2.	Cekur manis-*Sauropus androgynus*
3.	Jering-*Pithecellobium jiringa*
4.	Kacang kelisa-*Psophocarpus tetragonolobus*
5.	Kaduk-*Piper sarmentosum*
6.	Kerdas-*Pithecellobium bubalinum*
7.	Kesum-*Polygonum minus*
8.	Nangka (buah muda)-*Artocarpus integra*
9.	Paku (pucuk)-*Athyrium esculentum*
10.	Pegaga-*Hydrocotyle asiatica*
11.	Petai-*Parkia speciosa*
12.	Pisang (jantung)-*Musa sapientum*
13.	Selom-*Oenanthe javanica*
14.	Terung pipit-*Solanum torvum*
15.	Ubi kayu (pucuk)-*Manihot esculenta*
16.	Ulam raja-*Cosmos caudatus*
17.	Beluntas-*Pluchea indica*
18.	Betik (pucuk)-*Carica papaya*
19.	Cekur-*Kaempferia galanga*
20.	Gajus (pucuk)-*Annacardium occidentale*
21.	Gegeli-*Lasia spinosa*
22.	Kelor (daun)-*Moringa oleifera*
23.	Kemahang-*Colocasia esculenta*
24.	Keman-*Neptunia prostrata*
25.	Kermak-*Alternanthera triandra/sessilis*
26.	Mengkudu (pucuk)-*Morinda citrifolia*
27.	Pina-pina-*Pterococcus corniculatus*
28.	Putat (pucuk)-*Barringtonia racemosa*
29.	Paku rawan-*Limnocharis flava*
30.	Salang-*Claoxylon longifolium*
31.	Setang-*Melia excelsa*
32.	Tapak itik-*Marsilis minuta*

Literature search using multiple electronic databases based on the list of 32 popular *ulam* vegetables in Malaysia.[13]

⇩

Initial database search found a total of 55 studies that evaluated *ulam* and the modulation of blood glucose that investigated 11 species of *ulam* vegetables as the following:

1. Kermak putih (*Alternanthera sessilis*) = 2 studies (animal 1; human 1)
2. Daun gajus (*Anarcadium occidentale* leaf) = 4 studies (animal 4; human 0)
3. Daun betik (*Carica papaya* leaf) = 4 studies (animal 4; human 0)
4. Daun pegaga (*Centella /Hydrolyte asiatica*) = 3 studies (animal 1; human 2)
5. Daun Ulam raja (*Cosmos caudatus*) = 1 study (in vivo 1; animal 0; human 0)
6. Buah/daun peria katak (*Momordica charantia* fruit/leaf) = 32 studies (in vitro 3; animal 20; human 9)
7. Daun Kelor (*Moringa oleifera* leaf) = 1 study (in vivo 1; human 0)
8. Buah petai (*Parkia speciosa* pod) = 1 study (in vivo 1; human 0)
9. Biji jering (*Pitchebilium jiringa* seed) = 2 studies (in vivo 2; human 0)
10. Daun kaduk (*Piper somersantum* leaf) = 1 study (in vivo 1; human 0)
11. Daun jambu (*Psidium guajava* leaf) = 4 studies (in vitro 2; in vivo 2; human 0)

⇩

After excluding *in vitro* and animal studies, the literature search identified 11 studies that investigated 3 species of *ulam as the following:*

1. Peria katak (*Momordica charantia*) = *9 studies
2. Daun pegaga (*Centella asiatica*) = 2 studies
3. Kermak putih (*Alternanthera sessilis*) = *1 study

*studied in the similar research[21]

Figure 1. Flow chart of the review process

to the significant increments of postprandial blood insulin levels that were also observed at the 15-min time point during the experiment.[9]

Centella asiatica known as daun pegaga

Two studies assessed the effects of C. asiantica (daun pegaga) on blood glucose-related parameters in diabetics[15] and in healthy individuals.[23] Patients with diabetes were given the total triterpenic fraction of C. asiantica for a 6-month period. The triterpenic fraction was selected as it had been previously shown to improve microcirculation and capillary permeability among diabetic patients with hypertension and edema. However, the authors found no significant changes in fasting blood glucose and HbA1c concentrations following treatment.[15] Despite no significant changes in blood glucose-related parameters, *C. asiatica* supplementation reduced capillary permeability and improved microcirculation in the diabetic patients. However, this randomized control trial had a score of 2 on the Jadad scale, which indicated a low quality study. In a non-randomized controlled study among healthy individuals, incorporating *C. asiatica* into meals did not produce any significant improvement in postprandial concentrations when compared with two other plants i.e. *Trichosanthes cucumerina* (Petola ular) and *Lasia spinosa* (Geli-geli), not classified as *ulam*.[23]

Alternanthera sessilis, known as kermak putih

Only one case-series investigated the efficacy of *A. sessilis* (kermak putih) in lowering postprandial blood glucose concentrations among healthy individuals and type 2 diabetes mellitus patients.[21] In that study, no significant reduction was seen in the 3-h blood glucose concentration after consuming *A. sessilis* compared with a standard control meal (ie *Colocasia* leaves and *M. Charantia*) in diabetic or healthy subjects.

DISCUSSION

Among the *ulam* vegetables that are commonly consumed by the Malaysian population,[13] we found that only *M. charantia* followed by *C. asiatica* and *A. sessilis* have been widely studied for the reduction of blood glucose-related parameters in vivo, in vitro and in clinical trials. For *M. charantia*, only case series and controlled trial between year 1970 and 1990 showed significant reduction in blood glucose-related parameters. However, randomized control trials found no such effects. This may reflect factors related not only to research design but also to the mode of administration and the duration of the study. In fact, the form of *M. charantia* administration widely differed among studies with two studies using capsules/tablets,[8,9] one study using an aqueous extract by subcutaneous injection,[17] and the remaining studies using a juice form,[19,22] or oral ingestion.[16]

In terms of the method of administration, we found that *M. charantia* ingested in either fruit or leaves when encapsulated into pill or tablet form[8,9] did not significantly reduce blood glucose levels compared with when it was consumed orally,[16] injected subcutaneously under skin[17] or in juice form.[19,22] It was noted that the easiest and most non-invasive administration was through oral of an encapsulated tablet but efficacy in reducing blood glucose

Table 2. Summary of human studies that evaluated the effects of *ulam* on glycemic parameters, either on fasting or postprandial glycemic responses in healthy and diabetic subjects

No	Author	Study design	Types of *ulams* tested	Local name	Country	Type of subjects (sample size)	Impact	Safety issues	Jadad scale
1.	Grover & Gupta, (1973)[16]	Controlled trial	*Momordica charantia*	Peria katak	India	Diabetics (n=20)	Significant reduction in postprandial blood glucose	A few cases of headache	n/a
2.	Baldwa et al, (1977)[17]	Controlled trial	*Momordica charantia*	Peria katak	India	Diabetics (n=9)	Significant reduction in blood glucose level	-Nil	n/a
3.	Leatherdale et al, (1981)[19]	Case series	*Momordica charantia*	Peria katak	United Kingdom	Diabetics (n=9) Period =8-11 weeks	Significant reduction in postprandial blood glucose at 60 and 90-min.	-Nil	n/a
4.	Khanna et al, (1981)[18]	Controlled trial	*Momordica charantia*	Peria katak	India	Diabetics (n=19)	Significant reduction in serum glucose level	-Nil	n/a
5.	Welihinda et al, (1986)[20]	Case series	*Momordica charantia*	Peria katak	Sri Lanka	Diabetics (n=8) Period =2 days	Significant reduction in postprandial blood glucose	-Nil	n/a
6.	Sreedevi & Chaturdevi, (1993)[21]	Case series	*Alternanthera Sessilis* *Momordica charantia* *Colocasia antiquorum*	Kermak putih Peria katak Keladi	India	Healthy (n=8) and Diabetics (n=6) for healthy (36 days with a 2 day interval between 2 diets) for diabetics (15 days with a 2 day interval between 2 diets)	Peria katak is better in reducing blood glucose levels than the other 2 leaves for both healthy subjects and diabetics.	-Nil	n/a
7.	Ahmad et al, (1999)[22]	Case series	*Momordica charantia*	Peria katak	Bangladesh	Moderate non-insulin dependent diabetic subjects. (n=100)	Significant reduction in both fasting and post-prandial serum glucose levels.	-Nil	n/a
8.	Cesarone et al, (2001)[15]	Randomized control trial	*Centella asiatica*	Daun pegaga	United Kingdom	Diabetic microangiopathy patients. (n=50) Period =6 months	No significant change in fasting blood glucose or HBA1C levels.	-Nil	2
9.	Dans et al, (2007)[8]	Randomized control trial	*Momordica charantia*	Peria katak	Philippines	Diabetics (n=40) Period =3 months	No significant effect on fasting blood glucose from capsules of MC with placebo	Gastrointestinal complaint, epigastric pain and diarrhea	5
10.	Lim et al, (2010)[9]	Randomized control trial	*Momordica charantia*	Peria katak	Philippines	Diabetics (n=40)	Significantly lower blood glucose levels after 15 mins compared to that after placebo use	-Nil	5
11.	Hettiarachi et al, (2011)[23]	Case series	*Centella asiatica* *Lasia spinosa* *Trichosanthes cucumerina*	Daun pegaga Geli-geli Petola ular	Sri Lanka	Healthy subjects (n=12) Period =2 days	No significant difference for incremental areas under unit (IAUC) between 3 meals	-Nil	n/a

was only observed when *M. charantia* was consumed in raw or juice form. Hence, the methods of administratio of *M. charantia* should be considered in future studies. *M. charantia* is usually eaten in a raw and fresh form by most Malaysians. Studies should therefore investigate the effect of *ulam* in modulating blood glucose when consumed in fresh form.[3] Indeed, two studies that used fresh juice showed promising results,[19,22] hence, future studies are warranted to determine the effect of consuming *M. charantia* fresh or in a juice form rather than as tablet or capsules.[8,9] Furthermore, longer trials are needed as most clinical trials between 1970 and 1990 were acute exposure studies[16,17,19,22] rather than chronic exposure studies.[8]

Three different constituents of *M. charantia* namely charantin, alkaloid and insulin-like peptide, have been highlighted as the active ingredients in modulating blood glucose concentration.[24,25] Despite the blood-glucose lowering effects of *M. charantia*, diabetic patients are advised to consult a physician before using this compound especially in the concentrated tablet form because previous studies have shown gastrointestinal-related side effects including epigastric pain and diarrhea when consumed as concentrated capsules.[8] A well-designed interdisciplinary study is highly recommended before *M. charantia* can be commercialized.[24] *M. charantia* has not only been long used to control blood glucose concentrations by Malaysians but also by individuals in other countries such as India.[20] This *ulam* is also considered to be beneficial in the treatment of other disorders such as boils, scabies, itching, ringworm, and fungal diseases.[28]

A randomized control trial study[15] using *C. asiatica* was classified as low quality according to Jadad classification because it was not double blinded and because the technique of randomization was not described appropriately.[14] In another study by Hettiaratchi et al,[23] the control meals used as the reference were not described. Detailed information regarding the reference meal used is important as a basis of comparison purposes to the test meals that include *ulam*. Overall, both of these clinical studies did not agree with the outcomes provided from other in vitro and in vivo studies. An in vitro profiling study for example, *C. asiatica* was reported to possess various types of phytochemicals such as asiaticoside, madecasoside, asiatic acids, centellin, asiaticin and cetellicin,[29,30] all of which exert antioxidant activity that can play a role in blood glucose control regulation. In an in vivo study, *C. asiatica* was tested in diabetic rats using methanolic and ethanolic extracts, showing promising results. This compound is thought to have anti-diabetic properties comparably to glibenclamide; an oral antidiabetes agent, and in long term treatment, reverse kidney damage in alloxan-induced diabetic renal injury in rats.[31]

The use of *A. sessilis* (kermak putih) has been more frequently reported as an antimicrobial agent that expedites wound healing than for the modulation of blood glucose concentrations.[32] Despite an in vivo study in rats documenting promising results, *A. sessilis* has not shown any significant reduction in postprandial blood glucose in humans.[21] In an animal study, administration of either the alcoholic or aqueous extract of *A. sessilis* showed a significant reduction in blood glucose concentrations of STZ-induced diabetic rats.[33] To date, no in vitro investigations have been conducted to identify the active ingredients of *A. sessilis* nor to elucidate its phytochemical or antioxidant activity on blood glucose levels.

Other potential ulam vegetables

Other *ulam* vegetables such as *Carica papaya* stem (pucuk betik),[34-36] *Archidendron jiringa* (jering),[37] *Anacarduim occidentale* leaves (pucuk gajus),[38-41] *Morinda citrifolia* (mengkudu),[42,43] *Moringa oleifera* (kelor),[44] *Parkia speciosa* (petai),[45] *Leucaena leucephala* (petai belalang),[46] *Averrhoa bilimbi* (belimbing buluh),[47,48] and *Psidium guajava* leaves (pucuk jambu),[49] have only been investigated in animal studies and have shown promising results. However, other commonly consumed *ulam* vegetables among Malaysians such as *Cosmos caudatus* (ulam raja) and *Pereskia bleo* (jarum tujuh) have only been assessed at the in vitro level.[2,50,51] Therefore, further studies are warranted to determine the efficacy of these *ulam* vegetables in modulating blood glucose concentrations in humans, particularly in a raw or fresh form together with rice-based meals, as commonly consumed in Malaysia.

Potential mechanism of ulam and blood glucose control

In vitro studies have indicated that *ulam* has powerful antioxidant properties. Carotenoid substances including neoxanthin, violaxanthin, lutein and β-carotene are among powerful antioxidants found in *ulam*.[7] The total phenolic is also believed to play a role in the antioxidant activity of these vegetables.[2,6] The presences of these antioxidants may negate the effects of oxidative stress caused by hyperglycaemia.[52] This is pertinent in the present context because an excessive increase in blood glucose levels particularly in the postprandial state can contribute to the toxic effect on blood vessel walls.[53] The presence of high glucose and free fatty acids during the postprandial state overwhelms the Krebs's cycle resulting in excessive generation of free radicals such as superoxide anion, thereby triggering a number of atherogenic changes such as inflammation of endothelial cells. The inflammatory nature of postprandial dysmetabolism is evidenced by immediate postprandial increases in C-reactive protein, cytokines, adhesion molecules, clotting factors, and endothelin-1.[54] Oxidative stress has been linked to pathogenic mechanisms that lead to insulin resistance with dysfunction of both beta cells and endothelium which can progress to diabetes.[55] In addition, oxidative stress conditions reduce endothelial nitric oxide function, which is responsible for prevention of thrombosis and atherosclerosis.[56] Repeated episodes of oxidative stress on endothelial wall during postprandial state can lead to endothelial dysfunction, a condition that is considered as a preliminary risk factors for the development of atherosclerosis and ultimately cardiovascular diseases.[56]

Conclusion

To the best of our knowledge, although there are health claims regarding its medicinal effect, few clinical studies have investigated the effect of *ulam* on blood glucose modulation. A total of 55 studies related to *ulam* were identified; however after excluding in vitro and animal studies, only 11 clinical trials were found that involved three species of *ulam* namely *M. charantia* or known as "peria katak", *C. asiatica* known as "daun pegaga" and *A. sessilis* known as "kermak putih". Of these, only *M. charantia* has been extensively studied in various experimental designs. To date, there is insufficient evidence to show the effectiveness of traditional Malaysian vegetables (*ulam*) in modulating blood glucose concentrations. Further long-term studies are highly recommended to clarify the blood glucose-lowering properties of *ulam* vegetables.

ACKNOWLEDGEMENTS
The authors would like to thank all the elderly people who have shared their opinion, knowledge and ancestral claims about *ulam* in relation to blood glucose concentrations.

AUTHOR DISCLOSURES
The authors have declared no conflict of interest. This work was supported by Agro Biotechnology Institute, Ministry of Science, Technology and Innovation Malaysia (10-05-ABI-AB037).

REFERENCES
1. Huda-Faujan N, Noriham A, Norrakiah AS, Babji AS. Antioxidative activities of water extracts of some Malaysian herbs. ASEAN Food J. 2007;14:61-8.
2. Reihani SFS, Azhar ME. Antioxidant activity and total phenolic content in aqueous extracts of selected traditional Malay salads (Ulam). Int Food Res J. 2012;19:1439-44.
3. Izzah AN, Aminah A, Pauzi AM, Lee YH, Rozita WMW, Fatimah DS. Patterns of fruits and vegetable consumption among adults of different ethnics in Selangor, Malaysia. Int Food Res J. 2012;19:1095-107.
4. Abas F, Lajis NH, Israf D, Khozirah S, Umi Kalsom Y. Antioxidant and nitric oxide inhibition activities of selected Malay traditional vegetables. Food Chemistry. 2006;95:566-73. doi: 10.1016/j.foodchem.2005.01.034.
5. Mohd Shukri M, Mirfat A, Erny Sabrina M, Razali M, Salma I. Nutritional value and potential of Malaysian underutilised fruits and traditional vegetables. II international symposium on underutilized plant species: crops for the future-beyond food security; 2011. pp. 979
6. Mohd Shukri M, Alan C, Noorzuraini AS. Polyphenols and antioxidant activities of selected traditional vegetables. J Trop Agric and Food Sci. 2011;39:69-83.
7. Fatimah AMZ, Norazian MH, Rashidi O. Identification of carotenoid composition in selected 'ulam' or traditional vegetables in Malaysia. Int Food Res J. 2012;19:527-30.
8. Dans AML, Villarruz MVC, Jimeno CA, Javelosa MAU, Chua J, Bautista R et al. The effect of momordica charantia capsule preparation on glycemic control in type 2 diabetes mellitus needs further studies. J Clin Epidemiol. 2007;60: 554-9. doi: 10.1016/j.jclinepi.2006.07.009.
9. Lim ST, Jimeno CA, Razon-Gonzales EB, Velasquez MEN. The MOCHA DM study: the effect of MOmordica CHArantia tablets on glucose and insulin levels during the postprandial state among patients with type 2 diabetes mellitus. Philipp J Intern Med. 2010;48:19-25.
10. Vuksan V, Sievenpiper JL, Koo VYY, Francis T, Beljan-Zdravkovic U, Xu Z et al. American ginseng (Panax-quinquefolius L) reduces postprandial glycemia in non-diabetic subjects and subjects with type 2 diabetes mellitus. Arch Intern Med. 2000;160:1009-13. doi: 10.1001/archinte.160.7.1009.
11. Sotaniemi EA, Haapakoski E, Rautio A. Ginseng therapy in non-Insulin-dependent diabetic patients: effects on psychophysical performance, glucose homeostasis, serum lipids, serum amino terminal propeptide concentration, and body weight. Diabetes Care. 1995;18:1373-5. doi: 10.2337/diacare.18.10.1373.
12. Vuksan V, Sievenpiper JL, Xu Z, Wong EYY, Jenkins AL, Beljan-Zdravkovic U et al. Konjac-Mannan and American Ginsing: emerging alternative therapies for type 2 diabetes mellitus. J Am Coll Nutr. 2001;20:370-80. doi: 10.1080/07315724.2001.10719170.
13. Nor Azura AZ. Ulam Tradisional Malaysia. 2007/12/23 [cited 2013/4/15]; Available from: http://kebunwarisan.blogspot.com/2007/12/ulam-tradisional-malaysia.html.
14. Jadad AR, Moore RA, Carroll D, Jenkinson C, Reynolds DJM, Gavaghan DJ et al. Assessing the quality of reports of randomized clinical trials: is blinding necessary? Clin Trials. 1996;17:1-12. doi: 10.1016/0197-2456(95)00134-4.
15. Cesarone MR, Incandela L, Sanctis MTD, Belcaro G, Bavera P, Bucci M et al. Evaluation of treatment of diabetic microangiopathy with total titerpenic fraction of centella asiatica: a clinical prospective randomized trial with a microcirculatory model. Angiology. 2001;52:S49-54.
16. Grover JK, Gupta SR. Hypoglycemic activity of seeds of Momordica charantia. Ind J Exp Biol. 1973;58:1026-7. doi: 10.1016/0014-2999(90)92880-R.
17. Baldwa VS, Bhandari CM, Pangaria A, Goyal RK. Clinical trial in patients with diabetes mellitus of an insulin-like compound obtained from plant source. Ups J Med Sci. 1977; 82:39-41. doi: 10.3109/03009737709179057.
18. Khanna P, Jain SC, Panagariya A, Dixit VP. Hypoglycemic activity of polypeptide-p from a plant source. J Nat Prod. 1981;44:648-55. doi: 10.102 1/np50018a002.
19. Leatherdale BA, Panesar RK, Singh G, Atkins TW, Bailey CJ, Bignell AHC. Improvement in glucose tolerance due to Momordica charantia (Karela). BMJ. 1981;282:1823-4. doi: 10.1136/bmj.282.6279.1823.
20. Welihinda J, Karunanayake EH, Sheriff MHR, Jayasinghe KSA. Effect of Momordica charantia on the glucose tolerance in maturity onset diabetes. J Ethnopharmacol. 1986;17:277-82. doi: 10.1016/0378-8741(86)90116-9.
21. Sreedevi, Chaturvedi A. Effect of vegetable fibre on post-prandial glycemia. Plant Foods Hum Nutr. 1993;44:71-8. doi: 10.1007/BF01088484.
22. Ahmad N, Hassan MR, Halder H, Bennoor KS. Effect of momordica charantia (Karolla) extracts on fasting and postprandial serum glucose levels in NIDDM patients. Bangladesh Med Res Counc Bull. 1999;25:11-3.
23. Hettiaratchi UPK, Ekanayake S, Welihinda J. Sri Lankan rice mixed meals: effect on glycaemic index and contribution to daily dietary fibre requirement. Malays J Nutr. 2011; 17:97-104.
24. Paul A, Raychaudhuri SS. Medicinal uses and molecular identification of two momordica charantia varieties-a review. Electronic Journal of Biology. 2010;6(2):43-51.
25. Raman A, Lau C. Anti-diabetic properties and phytochemistry of momordica charantia L. (Cucurbitaceae). Phytomedicine. 1996;2:349-62. doi: 10.1016/S0944-7113(96)80080-8.
26. Krawinkel MB, Keding GB. Bitter gourd (Momordica charantia): a dietary approach to hyperglycemia. Nutr Rev. 2006;64:331-7. doi: 10.1111/j.1753-4887.2006.tb00217.x.
27. Kaushik G, Satya S, Khandelwal RK, Naik SN. Commonly consumed indian plant food materials in the management of diabetes mellitus. Journal of Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2010;4:21-40. doi: 10.1016/j.dsx.2008.02.006.
28. Abascal K, Ganora L, Yarnell E. The effect of freeze-drying and its implications for botanical medicine: a review. Phytother Res. 2005;19:655-60. doi: 10.1002/ptr. 1651.

29. Siddiqui BS, Aslam H, Ali ST, Khan S, Begum S. Chemical constituents of centella asiatica. J Asian Nat Prod Res. 2007; 9:407-14. doi: 10.1080/10286020600782454.
30. Zainol NA, Voo SC, Sarmidi MR, Aziz RA. Profiling of centella asiatica (L.) urban extract. The Malaysian Journal of Analytical Sciences. 2008;12:322-7.
31. Chauhan PK, Pandey IP, Dhatwalia VK, Singh V. Anti-diabetic effect of ethanolic and methanolic leaves extract of centella asiatica on alloxan induced diabetic rats. Int J Pharm Bio Sci. 2010;1:1-6.
32. Jalalpure SS, Agrawal N, Patil M, Chimkode R, Tripathi A. Antimicrobial and wound healing activities of leaves of alternanthera sessilis Linn. Int J of Green Pharm. 2008;2:141 -4. doi: 10.4103/0973-8258.42729.
33. Rao KVR, Rao KRSS, Nelson R, Nagaiah K, Reddy VJS. Hypoglycemic and anti-diabetic effect of alternanthera sessilis in normal and streptozotocin (STZ)-induced rat. J Global Trends Pharmaceut Sci. 2011;2:325-35.
34. Adeneye AA, Olagunju JA. Preliminary hypoglycemic and hypolipidemic activities of the aqueous seed extract of carica papaya Linn. in Wistar rats. Biology and Medicine. 2009;1:1-10.
35. Fakeye TO, Oladipupo T, Showande O, Ogunremi Y. Effects of coadministration of extract of carica papaya Linn (family Cariaceae) on activity of two oral hypoglycemic agents. Trop J Pharm Res. 2007;6:671-8. doi: 10.4314/tjpr. v6i1.14645.
36. Sasidharan S, Sumathi V, Jegathambigai NR, Latha LY. Antihyperglycaemic Effects of ethanol extracts of carica papaya and pandanus amaryfollius leaf in streptozotocin-induced diabetic mice. Nat Prod Res. 2011;25:1982-7. doi: 10.1080 /14786419.2010.523703.
37. Radhiah S, Suhaila M, Noordin MM, Azizah AH. Evaluating the toxic and beneficial effects of Jering beans (archidendron jiringa) in normal and diabetic rats. J Sci Food Agric. 2011;91:2697-706. doi: 10.1002/jsfa.4516.
38. Sokeng SD, Lontsi D, Moundipa PF, Jatsa HB, Watcho P, Kamtchouing P. Hypoglycemic effect of anacardium occidentale l. methanol extract and fractions on streptozotocin-induced diabetic rats. Global J Pharmacol. 2007;1:1-5.
39. Tedong L, Dimo T, Dzeufiet PDD, Asongalem AE, Sokeng DS, Callard P et al. Antihyperglycemic and renal protective activities of anacardium occidentale (anacardiaceae) leaves in streptozotocin induced diabetic rats. Afr J Trad CAM. 2006;3:23-35. doi: 10.4314/ajtcam. v3i1.31136.
40. Alexander-Lindo RL, Morrison EYSA, Nair MG. Hypoglycaemic effect of Stigmast-4-en-3-one and its corresponding alcohol from the bark of anacardium occidentale (cashew). Phytother Res. 2004;18:403-7. doi: 10.1002/ptr. 1459.
41. Kamtchouing P, Sokeng SD, Moundipa PF, Watcho P, Jatsa HB, Lontsi D. Protective role of Anacardium occidentale extract against streptozotocin-induced diabetes in rats. J Ethnopharmacol. 1998;62:95-9. doi: 10.1016/S0378-8741 (97)00159-1.
42. Kamiya K, Hamabe W, Harada S, Murakami R, Tokuyama S, Satake T. Chemical constituents of morindacitrifolia roots exhibit hypoglycemic effects in streptozotocin-induced diabetic mice. Biol Pharm Bull. 2008;31:935-8. doi: 10.1248 /bpb.31.935.
43. Nayak BS, Marshall JR, Isitor G, Adogwa A. Hypoglycemic and Hepatoprotective activity of fermented fruit juice of morindacitrifolia (Noni) in diabetic rats. Evid Based Complement Alternat Med. 2011;2011:875293. doi: 10.1155 /2011/875293.
44. Ndong M, Uehara M, Katsumata S-i, Suzuki K. Effects of oral administration of moringa oleifera lam on glucose tolerance in goto-kakizaki and wistar rats. J Clin Biochem Nutr. 2007;40:229-33. doi: 10.3164/jcbn.40.229.
45. Fathaiya J, Mohamed S, Lajis MN. Hypoglycaemic effect of Stigmast-4-en-3-one, from Parkia speciosa empty pods. Food Chemistry. 1995;54:9-13. doi: 10.1016/0308-8146(95) 92656-5.
46. Syamsudin D, Simajuntak P. The effects of leucanea leucocephala (lmk) de wit seeds on blood sugar levels: an experimental study. International Journal of Science and Research. 2006;2:49-52.
47. Pushparaj P, Tan CH, Tan BKH. Effects of averrhoa bilimbi leaf extract on blood glucose and lipids in streptozotocin-diabetic rats. J Ethnopharmacol. 2000;72:69-76. doi: 10.10 16/S0378-8741(00)00200-2.
48. Tan BKH, Tan CH, Pushparaj PN. Anti-diabetic activity of the semi-purified fractions of averrhoa bilimbi in high fat diet fed streptozotocin-induced diabetic rats. Life Sci. 2005;76:2827-39. doi: 10.1016/j.lfs.2004.10.051.
49. Shen SC, Cheng FC, Wu NJ. Effect of guava (Psidium guajava Linn.) leaf soluble solids on glucose metabolism in type 2 diabetic rats. Phytother Res. 2008;22:1458-64. doi: 10. 1002/ptr.2476.
50. Loh SP, Hadira O. In vitro inhibitory potential of selected malaysian plants against key enzymes involved in hyperglycemia and hypertension. Mal J Nutr. 2011;17:77-86.
51. Wahab SIA, Abdul AB, Mohan SM, Al-Zubairi AS, Elhassan MM, Hassan MY. Biological activities of pereskia bleo extracts. Int J Pharmacol. 2009;5:71-5. doi: 10.3923/ijp. 2009.71.75.
52. Maritim AC, Sanders RA, Watkins JB. Diabetes, oxidative stress, and antioxidants: a review. J Biochem Mol Toxicol. 2003;17:24-38. doi: 10.1002/jbt.10058.
53. Avogaro A. Postprandial glucose: marker or risk factor? Diabetes Care. 2011;34:2333-5. doi: 10.2337/dc11-1442.
54. O'Keefe JH, Bell DSH. Postprandial hyperglycemia/ hyperlipidemia (postprandial dysmetabolism) is a cardiovascular risk factor. Am J Cardiol. 2007;100:899-904. doi: 10.1016/j.amjcard.2007.03.107.
55. Ceriello A, Motz E. Is oxidative stress the pathogenic mechanism underlying insulin resistance, diabetes, and cardiovascular disease? The common soil hypothesis revisited. Arterioscler Thromb. 2004;24:816-23. doi: 10.11 61/01.ATV.0000122852.22604.78.
56. Förstermann U. Nitric oxide and oxidative stress in vascular disease. Pflugers Arch. 2010;459:923-39. doi: 10.1007/s 00424-010-0808-2.
57. Würsch P, Pi-Sunyer FX. The role of viscous soluble fiber in the metabolic control of diabetes: a review with special emphasis on cereals rich in β-glucan. Diabetes Care. 1997; 20:1774-80. doi: 10.2337/diacare.20.11.1774.
58. Yokohama WH, Shao Q. Soluble fibers prevent insulin resistance in hamsters fed high saturated fat diets. Cereal Foods World. 2006;51:16-8. doi: 10.1094/CFW-51-0016.
59. Willis HJ, Thomas W, Eldridge AL, Harkness L, Green H, Slavin JL. Glucose and insulin do not decrease in a dose-dependent manner after increasing doses of mixed fibers that are consumed in muffins for breakfast. Nutr Res. 2011;31:42-7. doi: 10.1016/j.nutres.2010.12.006.

Review Article

Effectiveness of traditional Malaysian vegetables (*ulam*) in modulating blood glucose levels

Mohd Faez Bachok BSc[1], Barakatun-Nisak Mohd Yusof PhD[1], Amin Ismail PhD[1], Azizah Abdul Hamid PhD[2]

[1]*Department of Nutrition and Dietetics, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia*
[2]*Department of Food Science, Faculty of Food Science and Technology, Universiti Putra Malaysia, Serdang, Selangor, Malaysia*

传统马来西亚蔬菜 *ulam* 调节血糖水平的功效

ulam 指一组传统的马来西亚植物，无论是生的还是经过短暂的漂烫处理后都是马来西亚人的食物之一。多种 *ulam* 被认为具有降血糖的特性，但对 *ulam* 调节人体血糖水平的有效性知之甚少。本文旨在系统评估 *ulam* 在调节人类血糖水平的功效。不限时间的多个数据库被用于本文文献检索。根据先验的纳入和排除标准检索到 11 个研究。在这 11 个研究中，只有苦瓜（当地称为“*peria katak*”）被广泛研究，其次是积雪草（当地称为“*daun pegaga*”）和莲子草（当地称为“*kermak putih*”）。在这 11 个研究中，有 9 个研究评估了苦瓜对血糖的影响，其中 7 个显示至少有 1 个血糖浓度指标有显著改善。其余 2 个研究报告血糖没有显著改善，尽管根据 *Jadad* 评分这两项研究属于高质量设计。关于积雪草和莲子草的研究显示对血糖没有显著影响。目前的临床证据不支持 *ulam*，即使是苦瓜，有降低血糖作用这一流行的说法。因此，需要进一步的临床研究来验证苦瓜、积雪草和莲子草对血糖的调节作用。

关键词：药用植物、辅助治疗、糖尿病、血糖、临床试验