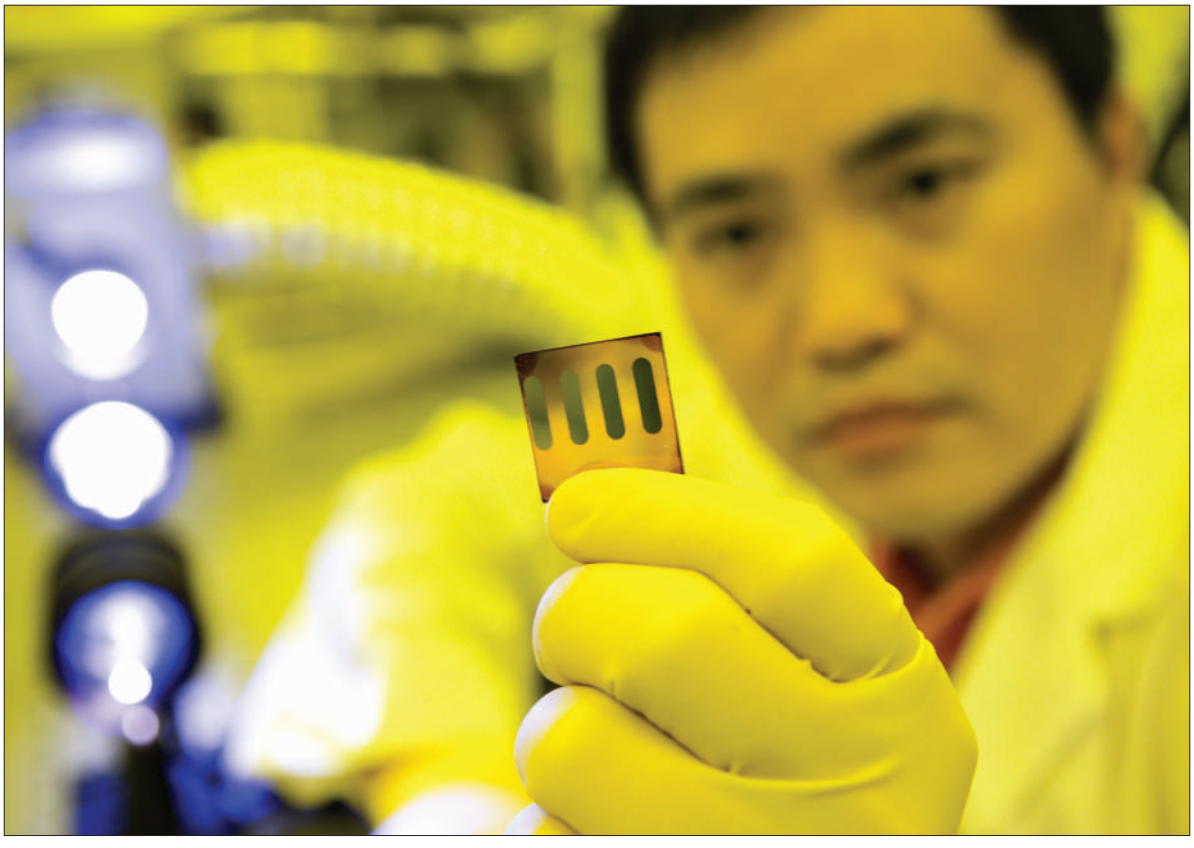

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Research Article
Trending Complementary Ethno-medication of Diabetes Mellitus in Khartoum: A Hospital-based Survey

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Abstract

Background and Objective: In spite of the observation of the extensive, ethnopharmacological, nutraceutical and condimental, use of herbals in the country, Sudanese use of herbal medicines is not adequately addressed. This unattended therapy impacts patient safe diabetic control, wherein conventional diabetes medications are combined to or abandoned in-favor of these herbs. The purpose of this study was to assess the current status of herbal medications, commonly used in the Sudanese ethnopharmacology, complementary to hypoglycemic agents among Sudanese diabetic patients. **Materials and Methods:** The two months, cross-sectional, hospital-based study enrolled (n = 260) diabetic patients. **Results:** Although the majority were Khartoum residents, many of them were from different states and belong to different tribes in Sudan. About 61.2% were females, whilst 49.6% aged above 40 years. The majority of the participants were type-2 diabetes mellitus patients. Almost 33.8% had developed hypertension secondary to diabetes mellitus. Almost 44.2% were free from complications. About 73.8% used herbal medications concurrently with their prescribed orthodox medications. **Conclusion:** The adjunct use of some herbs with anti-diabetic drugs produced significant positive therapeutic outcomes. A vista is opened for future larger scale investigations.

Key words: Ethnopharmacology, Diabetes Mellitus, sudanese, survey, herbal, hypoglycemic agent

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Diabetes Mellitus (DM) is a metabolic disorder resulting from a defect in insulin secretion, insulin action or both. It is characterized by chronic hyperglycemia[1].

Diabetes is the most common endocrine disorder and by the year 2010 it is estimated that more than 200 million people worldwide will have diabetes mellitus and 300 million will have the disease by 2025[1]. In general, the concept of a chronic disease as an asymptomatic condition is not well understood[2]. The majority of this diabetic population will emerge from developing countries[3].The number of people with diabetes increased dramatically in the last decades, due to population growth, aging, urbanization and increasing prevalence of obesity and physical inactivity[4].

The American Diabetes Association (ADA) estimated the national costs of diabetes in the USA for the year 2002 to be $USA 132 billion, increasing to $USA 192 billion in 2020[4]. Elamin *et al.*[5] reported that, due to limited resources in Sudan, most of the patients (51%) had reduced or abandoned insulin therapy due to non-availability or no afford ability of this drug and that most patients did not receive satisfactory diabetes care or education, leading to lower rates of clinic attendance (55%) and had poor dietary knowledge (78.5%).

DM as the most common non-communicable disease in the country, is generally believed to be incurable and the few drugs available to manage the disease are not readily affordable to the poor people[6], who represent the majority of Sudanese population[2].

Data from a small-scale study estimated a prevalence of 3.4% for the morbidity and mortality of DM in Sudan[7], whilst a recent report estimates the diabetic population at around one million, 95% of which is type 2 diabetes mellitus[8].

Many factors govern the control of diabetes among Sudanese patients including economic factors[2] and the educational level wherein the illiteracy level approaches 55%[2].

Sudan encompasses different terrains and climatic zones, with huge flora that consists of 3137 species of flowering plants. The intersection of diverse cultures and the unique geography holds great potential for Sudanese use of herbal medicine. It is reported that it has become the norm, particularly among the urban population of the country, to stop diabetes medications, reduce the prescribed doses or shift to a cheaper unsuitable drugs or herbs of unproven efficacy and safety[9]. Healthcare providers at diabetic follow up clinics observe some patients with fluctuating glycemic control that can only be owed to concealed use of herbal traditional complementary medicine (TCM) that adversely affect the management of their cases[2].

There has been a considerable effort to search for more effective drugs. This has resulted in a renewed interest in research to investigate the health benefits of herbs and natural products. Research on the desired pharmacological effects and possible unwanted side effects or toxicity is required to improve efficacy and safety of Sudanese herbal medicines despite the availability of various classes of conventional anti-diabetic agents[10].

The purpose of this study was to assess the efficacy of herbal medications, commonly used in the ethno pharmacology of diabetes mellitus.

The rationale behind this work was the wide use of nutraceutical herbs as hypoglycemic agents, together with the absence of supporting evidence of their efficacy and/ or safety.

MATERIALS AND METHOD

Ethical considerations: The study has been approved by the National Committee at The Research Department, Khartoum State Ministry of Health, in the form of Ethical Clearance. Patient Informed Consent has been filled by all the patients, who have participated in the study or their co-patients on individual basis.

Study design

Study area: Hospitals were selected according to their capacity to fit the study criteria and provide the study population adequate to address the study design, namely; Khartoum Teaching Hospital, including its Diabetes Referral Clinic during the summer, 2013. In addition to Al-Ribat Teaching Hospital with its Special Diabetic Unit and Diabetes Education Center.

Study population: Type-1 and type-2 diabetes mellitus patients attending the outpatient clinics in the two selected hospitals were enrolled in the study.

Sample size: The simple formula for sample size determination ($N = PQZ^2/d^2$) has been used to estimate the present sample size (N = 384).

Where:

N = Sample size
P = Prevalence factor
Q = 1-p
Z = Constant 95% occurred 1.96
d = Desired margin

Data collection: Patients were interviewed using a pre-designed questionnaire that contained items which are directly related to diabetes and the concurrent use of herbs with conventional anti-diabetic drugs.

The questionnaire covered all the important parameters, including the patients' personal information, diabetic history, medications, complementary medications history and experience.

With regards to their diabetes condition, the patients have been investigated regarding the disease's type, duration, the date of diagnosis and the current medications used.

In addition, regarding the complimentary herbals, questions covered the type of herbals used, source of prescription, frequency of use, adherence to use, experience of any effect(s) and if he/she had informed his/her doctor.

Data analysis: Statistical evaluation was performed with Statistical Package for Social Science (SPSS) computer program ver.16 release 16.0.0 (Sept. 13, 2007), copyright (c) SPSS Inc. USA. Data were analyzed by means of the Chi-square test to compare the mean differences for various results. The differences were considered to be significant at $p \leq 0.05$.

RESULTS

Patients characteristics: The gender distribution of the study population was 98(38.5%) males and 156(61.4%) females. The average age of the subjects enrolled into the study was 65 years old. The educational level of the

Table 1: Population characteristics, n = 260

	Herbs (n = 254)	
Patterns	Frequency/percentage	p-value
Age		
Children (0-15)	2 (00.78)	0.474
Adult (16-40)	58 (22.8)	
Elderly (41-60)	126 (49.6)	
Geriatric (>60)	68 (26.7)	
Gender		
Male	98 (38.5)	0.000
Female	156 (61.4)	
Residence		
Capital	98 (38.5)	0.045
Central	85 (33.4)	
West	23 (9.0)	
East	17 (6.1)	
South	1 (0.3)	
North	30 (11.8)	
Patient education		
Illiterate	62 (24.4)	0.973
Primary	56 (22.0)	
Secondary	65 (11.0)	
University	71 (25.5)	

Table 2: Summary of the respondents answer to the questions regard the herb use based on their educational level, n = 254

	Illiterate n = 62	Primary n = 56	Secondary n = 65	University n = 71	
Qu./Edu.	Frequency/percentage	Frequency/percentage	Frequency/percentage	Frequency/percentage	p-value
How often did you use herbs?					0.007
Daily	34 (13.3)	27 (10.6)	24 (9.4)	20 (7.8)	
Weekly	4 (1.5)	4 (1.5)	9 (3.5)	13 (5.1)	
Other	24 (9.4)	25 (9.8)	32 (12.5)	38 (14.9)	
Did you experience any side effects from herbs use?					0.141
Yes	47 (18.5)	28 (11.0)	29 (11.4)	43 (16.0)	
No	7 (2.7)	12 (4.7)	14 (5.5)	15 (5.9)	
Not sure	8 (3.1)	16 (6.2)	22 (8.6)	13 (5.1)	
Do you intend to use herbs again?					0.000
Yes	57 (22.4)	54 (21.2)	56 (22.0)	63 (24.8)	
No	4 (1.5)	1 (0.39)	8 (3.1)	6 (2.3)	
Missed	1 (0.3)	1 (0.3)	1 (0.3)	2 (0.78)	
Why do you insist to use herbs?					0.001
Safe	7 (2.7)	14 (5.5)	16 (6.2)	22 (8.6)	
Effective	51 (20.0)	35 (13.7)	45 (17.7)	43 (16.0)	
Cheap	4 (1.5)	5 (1.9)	5 (1.9)		00.00
Others	0 (0.0)	0 (0.0)	1 (0.39)	0 (0.0)	

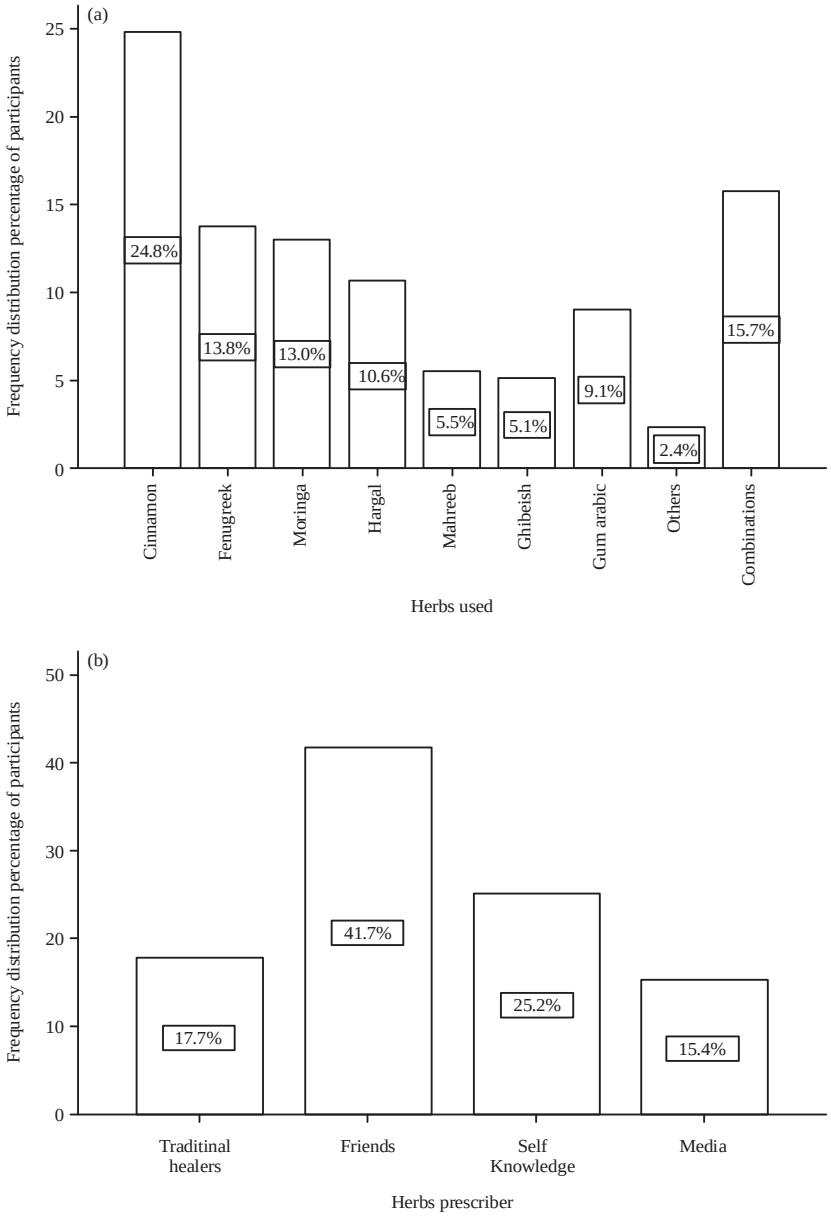

Fig. 1(a-b): Common herbs used by (a) Sudanese Diabetic patients and (b) Herbs used regarding their herbs prescriptions

participants ranged from illiterate to university graduates 62(24.4%) of the study patients were illiterate, 56 (22%) primary school graduates, 65 (11%) secondary school graduates and 71 (25.5%) university graduates. Considering the residence distribution of the study population, 98 (38.5%) lived in the capital, Khartoum, whilst only one patient (0.3%) was from Southern Sudan as shown in Table 1.

Common herbs used among diabetic patients: Most of the patients (n = 254) admitted the use of herbal complementary medicines, the commonly identified ones were Cinnamon (*Cinnamon verum*), Fenugreek (*Trigonella foenum*), Hargal (*Solenostemma argel*) and Moringa (*Moringa oleifera*). These results are shown in Fig.1a.

Those who had used herbals following an advice from a friend constituted 41.7% of the patients, while those who got them from a native doctor were 17.7% as expressed in Fig. 1b.

Disease status and medications among the participants: Considering the gender factor, 37.4% of the males and, 62.6% of the females were diagnosed with type-2 diabetes mellitus, (Fig. 2a).

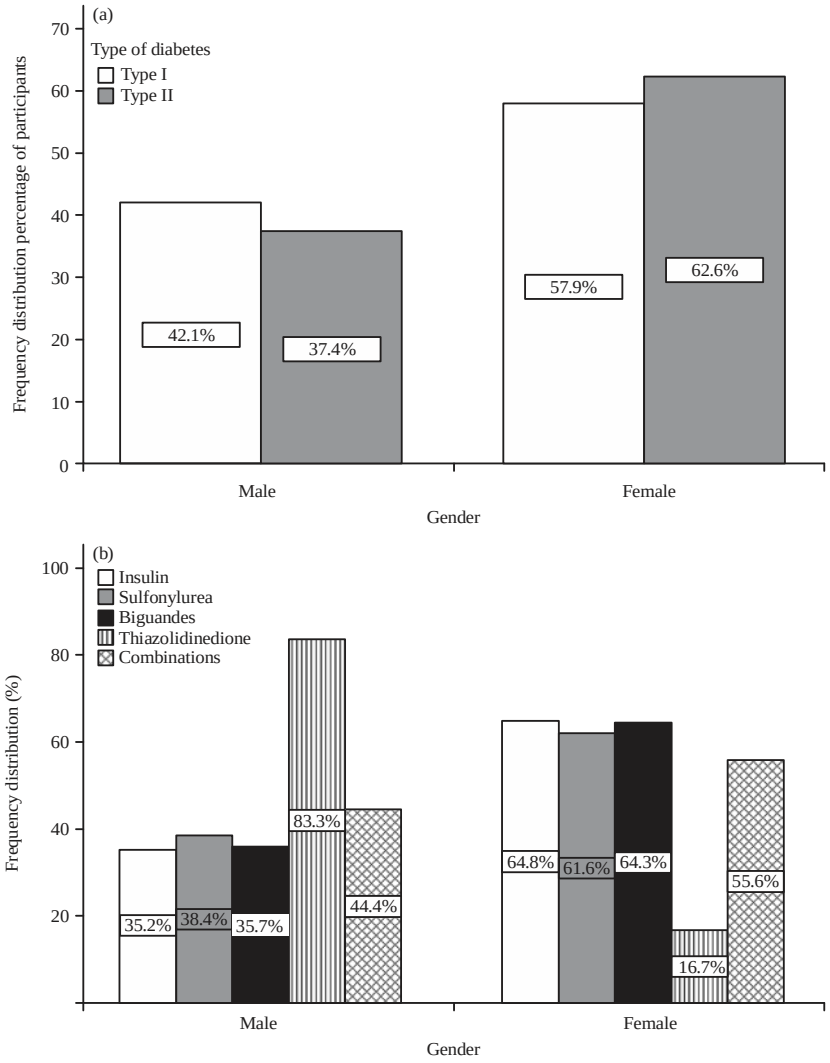

Fig. 2(a-b): (a) Patterns of the diabetes type and (b) Drug used based on gender (n = 254)

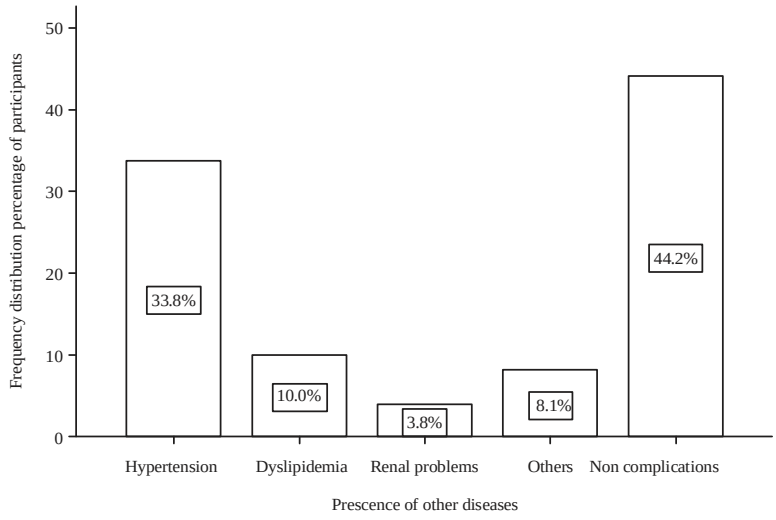

Fig. 3: Main other complications associated with DM among respondents represented as percentage

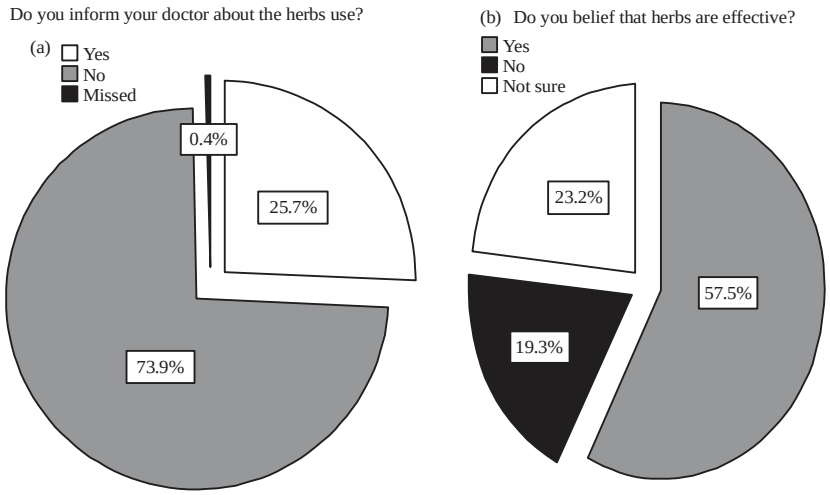

Fig. 4(a-b): Participants response to questions regarding their information of doctors of their (a) Herbs use and (b) Their opinions regarding the effectiveness of the herbs

Thiazolidinediones represented the most commonly used prescribed orthodox medications by the patients, constituting 83.3% of male patients and 16.7% female participants as shown in Fig. 2b.

Among the participants, 44.2% have not developed complications secondary to diabetes mellitus, while 33.8% developed hypertension as complication (Fig. 3).

Patterns of complementary herbal use: The majority of the patients did not inform their doctors about their concurrent use of herbal remedies with their prescribed anti-diabetic medications (Fig. 4a).

Among the diabetic patients, 57.5% believed that herbals were effective (Fig. 4b), 41.7%were on herbals through their friends' prescriptions (Fig. 1b).

Whilst, 7.8% of the university graduate used herbals on daily basis and 16%appreciated the effect of these herbal remedies (Table 2).

Effects of the herbals use concurrent with anti-diabetic drugs: More than half of the patients in the study (57.5%) reported positive experience pertaining to the impact of herbals on their therapy.

Less than a quarter 22.5% were not sure about the beneficial effects or harm of the concurrent use of herbal remedies with anti-diabetic agents, while 18.5% expressed negative reflections as shown in Fig. 4b.

DISCUSSION

The present study has shown the wide use of Cinnamon, Fenugreek, Hargal and Moringa as putative hypoglycemic herbs, complementary to conventional antidiabetic drugs. It has been determined that thiazolidinediones are the most commonly prescribed antidiabetic agents. It has been determined that most patients self-medicate themselves with these nutraceutical herbs without supervision of, or counselling from, their attending physicians. It has been shown that these herbals have positive impact on diabetic control.

The use of herbal remedies is not something new, as herbs have been known for a long time and had been used by many people to treat a variety of ailments. There is recently a resurgence of interest in the use of natural products, including herbs, in the treatment of diabetes[11].

From the suggested sample, only 260 patients met the study criteria and were fully enrolled to the study. This was partially due to the short period for data collection and partially due to the lack of co-operation by some patients.

The study characterization showed no significant variation in gender, residence and educational level among the participants, indicating the proper sample selection with minimum bias and the true phenomenon of distribution among the study population.

Because the study was conducted in Khartoum Teaching Hospital and Al-Ribat Teaching Hospital, most of the patients were from Khartoum territory.

Our findings revealed that, female patients represent the majority regarding herbs utilization, this can most likely be attributed to the fact that, socializing and circulation of information, regarding remedies in this case, is usually more common among ladies.

The commonly-used herbs among the patients are cinnamon, fenugreek and moringa, this is consistent with the

report that, fenugreek is an insulin secretagogue with hypoglycemic and lipid-lowering effects[12] and for that, it is used in the remedy of T2DM in India and South Africa along with a cohort of other 14 TCM[9]. The findings are also in line with another study which revealed that, cinnamon increases insulin sensitivity, expression and increases cellular glucose entry by enhanced insulin receptor phosphorylation and translocation of GLUT4 glucose transporter to the plasma membrane and promotes glycogen synthesis[11]. In a study conducted among American patients of Mexican origin[9], the most frequent herbs used were Nopal and Aloe Vera, while in Morocco fenugreek was the first in the top 10 most recommended anti-diabetic plants[12]. In India, plum was the herb most frequently used[13]. In Turkey some herbal teas and infusions are traditionally used in the treatment of diabetes[14]. In Thailand the herbal formula-Mathurameha consisting of 26 medicinal plants has been used as an alternative and complementary medicine for diabetes treatment in Wangnamyen Hospital[15]. In Taiwan Liu-Wei-Di-Huang-Wan and its derivatives were found to be the most common herbal formulae prescribed by Traditional and Complementary Medicine (TCM) doctors for the treatment of diabetes[16]. This variation could be related to the availability of these herbs in certain communities than others, besides, local traditions and cultural beliefs that play a major role in their ethno-pharmacological choices. A recent study to understand the usage of complementary therapies in managing Type 2 Diabetes Mellitus (T2DM), pointed out that patients perceptions of a disease and its management are largely based on their cultural background and environmental resources[11].

The majority of the participants showed persistent interest in using herbal remedies. This is consistent with a documented global trend estimated in a large scale study among 1,000,000 diabetic Chinese at 77.9%[16] and among Australians at 72.8%[17]. There is presently a common ethnic belief in the effectiveness of TCM regardless of their safety, especially considering the irregularity of their use, this is consistent with the previous observation that TCM users show decreased adherence to prescribed medications due to logistical and psychological burdens[9]. Many researchers have addressed the anti-diabetic effects of different herbs[14,18-28], however, the safety and efficacy of these herbal treatments still need to be determined[29,30]. It is reported that, the herbal medicines content of multiple bioactive components for which there is a lack of understanding of how these components interact with each other and with pharmaceutical orthodox medicines, when taken in combination, has raised safety concerns[17,11]. It is also known that, the chemical constitutions of some products vary based on the season, growing conditions, plant part used for extraction and the assay technique employed[11].

The majority of the respondents admitted to have started using herbs according to advices extended to them by their friends. This is in total agreement with a previous observation that the main reasons for TCM uses were friend and relative suggestions, as well as social media[31]. This draws attention to the importance of health education to the local communities. It is reported that, in the USA, ahead of most other nations, national non-governmental organizations, such as; the Accreditation Commission for Acupuncture and Oriental Medicine, the American Board of Medical Acupuncture, the Council of Chiropractic Education, accredit TCM education[9]. An experiment was performed with a view to provide focused attention on the development of education and research in these disciplines[11].However, the regulation of TCM practice still lags behind, the WHO published the 'Regulatory Situation of Herbal Medicines: a Worldwide Review'' with the sole aim of assisting its members in the development of policies and regulations[11].

All the respondents didn't inform their doctors concerning their herbal use, most probably due to concerns regarding the negative attitudes of doctors towards herbal remedies. This is consistent with the previous observations that, TCM practitioners usually do not encourage inquiries regarding the constituents of their preparations, that most patients are not very interested in knowing this as they consider such preparations to be 'natural' or 'safe' and that healthcare professionals are mostly unaware of TCM use by their patients and they are usually not consulted prior to their use[11,31]. However, the abovementioned observations are contrary to medication by herbal formulae prescribed and administered by many hospitals worldwide[15].

CONCLUSION

Diabetes is a condition in which the use of herbs is very obvious in an attempt to maintain the glucose level within the normal range in order to avoid and/or minimize the complications. This type of treatment should be based on scientific evidence.

Diabetes specialists should be aware of these facts and should try to encourage their patients in giving out the history of herbal use as it may affect the management outcomes of their disease condition.

It is recommended that, further well-designed clinical studies that enlist a large sample size to be conducted to investigate the potential role of herbs in the management of diabetes mellitus and their interactions with anti-diabetic medications.

Diabetic patients are recommended to increase their intake of vitamins and nutrients like B1, B6, B12, C and E as well as Biotin.

It is important to consult a doctor before adopting this practice.

SIGNIFICANCE STATEMENT

This study discovers that the adjunct use of Cinnamon (*Cinnamon verum*), Fenugreek (*Trigonella foenum*), Hargal (*Solenostemma argel*) and Moringa (*Moringa oleifera*) with anti-diabetic drugs can be beneficial for better therapeutic outcomes.

This study will help the researcher to uncover the critical areas of diabetic control using combination conventional antidiabetic drugs/local ethnopharmacologic medication that many researchers were not able to explore. Thus, a new theory on these nutraceutical combinations and possibly other combinations, may be arrived at.

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REFERENCES

1. Amos, A.F., D.J. McCarty and P. Zimmet, 1997. The rising global burden of diabetes and its complications: Estimates and projections to the year 2010. Diabetic Med., 14: S7-S85.
2. Ahmed, A.M. and N.H. Ahmed, 2001. Diabetes mellitus in Sudan: The size of the problem and the possibilities of efficient care. Pract. Diabetes Int., 18: 324-327.
3. Shaw, J.E., R.A. Sicree and P.Z. Zimmet, 2010. Global estimates of the prevalence of diabetes for 2010 and 2030. Diabetes Res. Clin. Pract., 87: 4-14.
4. Wild, S., G. Roglic, A. Green, R. Sicree and H. King, 2004. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. Diabetes Care, 27: 1047-1053.
5. Elamin, A., H. Altahir, B. Ismail and T. Tuvemo, 1992. Clinical pattern of childhood type 1 (insulin-dependent) diabetes mellitus in the Sudan. Diabetologia, 35: 645-648.
6. Abdelgadir, M., M. Elbagir, A. Eltom, M. Eltom and C. Berne, 2003. Factors affecting perinatal morbidity and mortality in pregnancies complicated by diabetes mellitus in Sudan. Diabetes Res. Clin. Pract., 60: 41-47.
7. Ahmed, A.M., N.H. Ahmed and M.E. Abdella, 2000. Pattern of hospital mortality among diabetic patients in Sudan. Pract. Diabetes Int., 17: 41-43.
8. Elbagir, M.N., M.A. Eltom, E.M.A. Elmahadi, I.M.S. Kadam and C. Berne, 1996. A population-based study of the prevalence of diabetes and impaired glucose tolerance in adults in Northern Sudan. Diabetes Care, 19: 1126-1128.
9. Hunt, L.M., N.H. Arar and L.L. Akana, 2000. Herbs, prayer and insulin. Use of medical and alternative treatments by a group of Mexican American diabetes patients. J. Fam. Pract., 49: 216-223.
10. Bogdanov, S., T. Jurendic, R. Sieber and P. Gallmann, 2008. Honey for nutrition and health: A review. J. Am. Coll. Nutr., 27: 677-689.
11. Kesavadev, J., B. Saboo, S. Sadikot, A.K. Das and S. Joshi *et al*., 2017. Unproven therapies for diabetes and their implications. Adv. Therapy, 34: 60-77.
12. Kibiti, C.M. and A.J. Afolayan, 2015. Herbal therapy: A review of emerging pharmacological tools in the management of diabetes mellitus in Africa. Pharmacogn. Mag., 11: S258-S274.
13. Baliga, M.S., S. Fernandes, K.R. Thilakchand, P. D'Souza and S. Rao, 2013. Scientific validation of the antidiabetic effects of *Syzygium jambolanum* DC (black plum), a traditional medicinal plant of India. J. Altern. Complement. Med., 19: 191-197.
14. Buyukbalci, A. and S.N. El, 2008. Determination of *in vitro* antidiabetic effects, antioxidant activities and phenol contents of some herbal teas. Plant Foods Hum. Nutr., 63: 27-33.
15. Chayarop, K., P. Peungvicha, R. Temsiririrkkul, Y. Wongkrajang, W. Chuakul and P. Rojsanga, 2017. Hypoglycaemic activity of Mathurameha, a Thai traditional herbal formula aqueous extract and its effect on biochemical profiles of streptozotocin-nicotinamide-induced diabetic rats. BMC Complement. Altern. Med., Vol. 17. 10.1186/s12906-017-1851-8.
16. Huang, C.Y., Y.T. Tsai, J.N. Lai and F.L. Hsu, 2013. Prescription pattern of chinese herbal products for diabetes mellitus in taiwan: A population-based study. Evidence-Based Complement. Altern. Med., Vol. 2013. 10.1155/2013/201329.
17. Gupta, R.C., D. Chang, S. Nammi, A. Bensoussan, K. Bilinski and B.D. Roufogalis, 2017. Interactions between antidiabetic drugs and herbs: An overview of mechanisms of action and clinical implications. Diabetol. Metab. Syndr., Vol. 9, No. 1. 10.1186/s13098-017-0254-9.
18. Kim, S., B.C. Shin, M.S. Lee, H. Lee and E. Ernst, 2011. Red ginseng for type 2 diabetes mellitus: A systematic review of randomized controlled trials. Chin. J. Integr. Med., 17: 937-944.
19. Lan, J., Y. Zhao, F. Dong, Z. Yan, W. Zheng, J. Fan and G. Sun, 2015. Meta-analysis of the effect and safety of berberine in the treatment of type 2 diabetes mellitus, hyperlipemia and hypertension. J. Ethnopharmacol., 161: 69-81.

20. Lian, F., J. Tian, X. Chen, Z. Li and C. Piao *et al*., 2015. The efficacy and safety of Chinese herbal medicine Jinlida as add-on medication in type 2 diabetes patients ineffectively managed by metformin monotherapy: A double-blind, randomized, placebo-controlled, multicenter trial. PLoS ONE, Vol. 10, No. 6. 10.1371/journal.pone.0130550.
21. Mirfeizi, M., Z.M. Tourzani, S.Z. Mirfeizi, M.A. Jafarabadi, H.R. Rezvani and M. Afzali, 2016. Controlling type 2 diabetes mellitus with herbal medicines: A triple-blind randomized clinical trial of efficacy and safety. J. Diabetes, 8: 647-656.
22. Perera, P.R.D., S. Ekanayake and K.K.D.S. Ranaweera, 2017. Antidiabetic compounds in *Syzygium cumini* decoction and ready to serve herbal drink. Evidence-Based Complement. Altern. Med., Vol. 2017. 10.1155/2017/1083589.
23. Said, O., S. Fulder, K. Khalil, H. Azaizeh, E. Kassis and B. Saad, 2008. Maintaining a physiological blood glucose level with 'glucolevel', a combination of four anti-diabetes plants used in the traditional Arab herbal medicine. Evidence-Based Complement. Altern. Med., 5: 421-428.
24. Tag, H., P. Kalita, P. Dwivedi, A.K. Das and N.D. Namsa, 2012. Herbal medicines used in the treatment of diabetes mellitus in Arunachal Himalaya, Northeast, India. J. Ethnopharmacol., 141: 786-795.
25. Tahraoui, A., J. El-Hilaly, Z.H. Israili and B. Lyoussi, 2007. Ethnopharmacological survey of plants used in the traditional treatment of hypertension and diabetes in South-Eastern Morocco (Errachidia province). J. Ethnopharmacol., 110: 105-117.
26. Tian, J., F. Lian, X. Yu, Y. Cui, T. Zhao, Y. Cao and X. Tong, 2016. The efficacy and safety of Chinese herbal decoction in type 2 diabetes: A 5-year retrospective study. Evidence-Based Complement. Altern. Med., Vol. 2016. 10.1155/2016/5473015.
27. Tong, X.L., S.T. Wu, F.M. Lian, M. Zhao and S.P. Zhou *et al*., 2013. The safety and effectiveness of TM81, a Chinese herbal medicine, in the treatment of type 2 diabetes: A randomized double-blind placebo-controlled trial. Diabetes Obes. Metab., 15: 448-454.
28. Vuksan, V., M.K. Sung, J.L. Sievenpiper, P.M. Stavro and A.L. Jenkins *et al*., 2008. Korean red ginseng (*Panax ginseng*) improves glucose and insulin regulation in well-controlled, type 2 diabetes: Results of a randomized, double-blind, placebo-controlled study of efficacy and safety. Nutr. Metab. Cardiovasc. Dis., 18: 46-56.
29. Khanna, P., S.C. Jain, A. Panagariya and V.P. Dixit, 1981. Hypoglycemic activity of polypeptide-P from a plant source. J. Nat. Prod., 44: 648-655.
30. Medagama, A.B. and R. Bandara, 2014. The use of Complementary and Alternative Medicines (CAMs) in the treatment of diabetes mellitus: Is continued use safe and effective? Nutr. J., Vol. 13. 10.1186/1475-2891-13-102.
31. Putthapiban, P., W. Sukhumthammarat and C. Sriphrapradang, 2017. Concealed use of herbal and dietary supplements among Thai patients with type 2 diabetes mellitus. J. Diabetes Metab. Disord., Vol. 16, No. 1. 10.1186/s40200-017-0317-3.