Journal of Diabetes and Metabolism

Al-Mssallem, J Diabetes Metab 2014, 5:11
DOI: 10.4172/2155-6156.1000452

Review Article Open Access

The Association between the Glycaemic Index of Some Traditional Saudi Foods and the Prevalence of Diabetes in Saudi Arabia: A Review Article

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Abstract

This article reviews some traditional Saudi foods in terms of their nutritive values, glycaemic index (GI) and insulinaemic index (II). The relationship between the consumption of these foods and the prevalence of diabetes in Saudi Arabia has been discussed. This review reveals that traditional Saudi foods are good source of healthy carbohydrates that are consumed in forms of whole grains where they will be rich in fibre, some vitamins and minerals. For example, 26 % and 16 % of the requirements of iron and fibre for adults can be provided from consuming a serving size of Harees. Moreover, the GI value of most traditional Saudi foods has fallen within low range. The II value of some traditional Saudi foods such as Hassawi rice and Khalas dates also reported which was 56 and 63, respectively. The lower GI and II for most traditional Saudi foods suggest that these foods may have benefits on postprandial glycaemic and insulinaemic levels. These important features of traditional Saudi foods could provide substantial contribution to the improvement of Saudi diets in the management and prevention of diabetes mellitus (DM) where there is a high rate of prevalence of DM in Saudi Arabia. The recent dramatic modification in Saudi diet in particular modifying the type of carbohydrates content of the diet was behind the most health problem. Dietary advice should be given and good strategies should be taken in order to diminishing the occurrence of health problem escalation.

Keywords: Traditional Saudi foods; Glycaemic index; Insulinaemic index

Introduction

Lifestyle and nutrition play a crucial role in the development or prevention of chronic conditions such as obesity, coronary heart disease and diabetes mellitus. It is well documented that the prevalence of diabetes is increasing dramatically worldwide at an alarming rate and the number of people with diabetes is projected to grow from 366 million in 2011 to 552 million in 2030 [1]. Diabetes and in particular type 2 diabetes mellitus (T2DM) has shown to be associated with obesity and an inactive lifestyle. In Saudi Arabia, there is a particularly high rate of prevalence of diabetes (24 %) and this may be due to the rapid socioeconomic changes which has led to increase rate of obesity over the last 3 decades [2,3].

Dietary carbohydrates (CHOs) have an important role in the management of diabetes. They are digested and absorbed at different rates and to different extents in human small intestine [4]. The glycaemic index has been introduced by Jenkins et al. [5] to aid our understanding of the metabolic impact of different types of CHO containing foods [6]. The effect of consumption of high GI foods and its associations with the progression to DM has been studied in large prospective cohort studies [7,8]. Reducing glucose response and subsequently insulin demand is the one target for the prevention and treatment of T2DM. It has been suggested that the high intake of low GI foods and dietary fibre are associated with a lower risk of T2DM [9]. However, the great health benefit of low GI foods remains to be fully elucidated.

This review will summarise the prevalence of diabetes in Saudi Arabia and the changes in Saudi eating patterns. Traditional Saudi foods and their nutritive values will be briefly discussed, with particular focus on the type of their CHO contents. The GI and insulinaemic index (II) concepts and their values for some Saudi foods will be also reviewed.

Definition and Prevalence of Diabetes Mellitus

Diabetes mellitus (DM) is a metabolic disorder characterised by hyperglycaemia and caused primarily by a defect in insulin secretion from the islet cells of the pancreas resulting in an inability of peripheral cells to use glucose [10]. The number of people with DM in the world is expected to rise from 2.8 % in 2000 to 7.7 % in 2030 due to population growth, aging, effects of modernisation, increase prevalence of obesity and decrease physical activity. It has been estimated that the greatest relative increases in the number of people with diabetes (163 %) will occur in the Middle Eastern region by the year 2030 [11,12].

DM is thought to develop for a variety of reasons. Indeed, several pathogenic processes ranging from autoimmune destruction of the β-cells of the pancreas with consequent insulin deficiency to abnormalities that result in the resistance to insulin action [10]. The majority of cases of diabetes fall into two categories: type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM). T1DM results from β –cell destruction leading to absolute insulin deficiency. Markers of the immune destruction of the β –cell include islet cell autoantibodies, autoantibodies to insulin, autoantibodies to glutamic acid decarboxylase and autoantibodies to tyrosine phosphatises. Some patients with this type of diabetes may present with ketoacidosis as the first manifestation of the disease. This type of diabetes commonly occurs in childhood and adolescence and accounts for only 5-10 % of those with diabetes. People with T1DM present with acute symptoms and markedly elevated blood glucose levels and they need insulin for survival [10].

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Received August 12, 2014; **Accepted** October 07, 2014; **Published** October 09, 2014

Citation: Al-Mssallem MQ (2014) The Association between the Glycaemic Index of Some Traditional Saudi Foods and the Prevalence of Diabetes in Saudi Arabia: A Review Article. J Diabetes Metab 5: 452 doi:10.4172/2155-6156.1000452

T2DM accounts for 90-95 % of those with diabetes and results from progressive insulin secretory defect. The cause of T2DM is thought to be due to a combination of environmental and genetic factors. Most of individuals with T2DM are obese and they do not usually need insulin treatment to survive. The risk of developing this form of diabetes increases with age, lack of physical activity, and obesity. Obesity itself or having an increased percentage of body fat distributed predominantly in the abdominal region causes some degree of insulin resistance. Insulin resistance may improve with weight reduction and/or hypoglycaemic treatment [10].

Prevalence of Diabetes Mellitus in Saudi Arabia

Saudi Arabia is a country that occupies four-fifths of the Arabian Peninsula [13]. After the discovery of oil in 1936, Saudi Arabia has undergone very rapid improvements in all aspects of lifestyle and standards of living [14]. The high level of food availability for consumption and the diversification of diet as well as sedentary lifestyles have resulted in large social changes and now the population is experiencing a high prevalence of DM [15-17]. A few epidemiological studies have been carried out and these have shown that the prevalence of DM was high relative to other countries [18,19]. The overall prevalence of DM in Saudi adults was 4.3 % in 1987 [19] but it is apparent that this number has increased about 6 times by 2004 [16]. It has been found that the highest percentage with diabetes was observed in the northern region of the country (28 %), but the southern region had the lowest prevalence (18%). DM is significantly more prevalent among Saudis living in urban areas (25%) compared to those living in rural areas (19%). Diabetes has also been shown to increase with age [16,18] with a prevalence of 12% and 36.5% at age ranges of 30-39 years and 60-70 years, respectively [16].

A large number of Saudi patients with diabetes are at a high risk for diabetic complications (nephropathy, neuropathy and retinopathy). Risk factors include their blood glucose, blood pressure and lipid are not achieving recommended levels. Also about a third of patients had undiagnosed hypertension and 17.6% of patients having low density lipoprotein (LDL) cholesterol values of more than 3.38 mmol/l, a level that suggests the need for lipid-lowering therapy [20,21].

Many factors are involved in influencing the prevalence of DM such as gender, age, socioeconomic status, genetic susceptibility and lifestyle. In Saudi Arabia, two of the main reasons for the increase in DM may be the increase in obesity and a major change in habitual eating patterns, including modifications in the quality and quantity of dietary carbohydrates [3,22].

Traditional Saudi Foods

It is well known that most of traditional Saudi foods are based on rice and whole grain wheat (See Table 1). The wheat based dishes include Harees (whole grain wheat cooked with meat), Mataziz, Qorsan and Marqooq (whole wheat dough with vegetables and meat), Gerish (cracked wheat cooked with vegetables and meat), Marassia, Aseedah, Maamool Tamer, Qors Tamer and Klaija [22,23]. In addition, the main dish that is served at lunch time consists of rice with vegetables and meat, the so called Kabsa [14,24]. There are other rice based dishes which are commonly consumed such as Briani, Bukhary and Mandi but they are not considered as a traditional Saudi dish as Kabsa. Other rice based dishes such as Saleeq (cooked with milk and served with tomato sauce and grilled chicken) and Mahalabia (cooked with milk and sugar and served with nuts as a dessert) are traditionally consumed in Saudi Arabia.

food	Serving size	Moisture (g)	Energy (cal)	CHO (g)	Protein (g)	Fat (g)	Fibre (g)	B1 (mg)	B2 (mg)	Fe (mg)	Ca (mg)	Na (mg)
Arabic coffee	25	24.7	1	0.15	0.03	0	0	0	0	0	0	0
Aseeda	75	49.43	99	18.6	3.6	1.13	1.5	0.03	0.07	0.06	-	219
Basmati rice Kabsa	150	97.1	213	43.2	4.2	2.5	1.2	0.06	0.96	0.3	1.5	301.5
Briani	150	89.4	252	48.1	5.1	4.3	1.5	0.03	0.03	1.35	1.5	378
Bukhary	150	98.2	207	39.3	4.8	3.4	1.6	0.05	0.05	1.2	7.5	465
Dates	60	12	183	43.8	1.32	0.36	1.44	0.05	0.06	1.26	43.2	0
Dates stuffed with nuts	90	12.78	369.9	45.9	7.68	17.37	3.69	0.09	0.23	2.19	115.2	0
Dates with Arabic Coffee	85	36.7	184.6	43.9	1.35	0.36	1.44	0.05	0.06	1.26	43.2	0
Dates with sour milk or yoghurt	185	122.1	257.3	50.5	5.3	3.6	1.44	0.05	0.06	1.26	193.2	0
Harees	150	119.2	105	43.2	3.6	0.6	4.05	0.06	0.06	2.7	0	165
Hassawi rice Kabsa	150	94.5	202.6	24.2	12.5	6.2	1.2	0.10	0.92	2.60	17.16	88.5
Klaija	30	2.6	114.6	15.03	2.58	4.92	1.8	0	0	0.69	1.5	28.2
Loqaimat	50	8.35	189	33.6	1.95	5.15	0.8	0	0	0.25	10.5	8.5
Maamool Tamer	40	2.6	187.6	24.48	2.68	8.56	1.32	0	0	0	0	-
Mahalbia	75	46.2	114	23.85	2.85	0.75	0.6	0.03	0.06	0.53	12	105.75
Mandi	150	92.8	235	45.7	5.1	3.6	0.9	0.03	0.03	1.2	3	1.5
Marassia	150	73.9	309	47.1	10.05	9	6.9	0.04	1.41	3.15	1.95	285
Marqooq	150	121.8	99	15.6	4.65	1.95	3.9	0.08	0.54	2.1	3	457.5
Mataziz	150	114.9	142.5	20.85	5.55	4.05	2.55	0.05	0.29	1.65	52.5	190.5
Moaddas	150	104.7	198	29.5	6.3	6.1	0.6	0.12	1.37	3.3	40.5	885
Qors Tamer	65	19.75	216.45	31.21	3.02	8.51	1.38	0.1	0.08	1.23	28.8	15.75
Qorsan	150	115.05	18.75	6.45	3.45	3.75	4.05	0.09	0.78	1.35	1.5	390
Saleeq	150	115.3	141	25	5.8	1.9	0.3	0	0	1.05	64.5	483
Siyadiyeh	150	99.1	223	30.6	9.9	6.9	1.6	0.03	0.14	0.6	0	375
Yoghurt, full fat-plain	125	110.1	73.7	6.7	4	3.25	0	0	0.23	0	150	0

Table 1: Nutritional composition for some traditional Saudi foods.

CHO, carbohydrate; B1, thiamine; B2, riboflavin; Fe, iron; Ca, calcium; Na, sodium

Another traditional food which is also important in Saudi culture is palm dates. Dates are mostly consumed in the Rutab or Tamer stage of development [25,26]. The highest consumption of Rutab or dates reaches its top in Ramadhan when all Saudi people prefer to break their fast with eating Rutab or dates. The most expensive variety of dates is called Ajwa from Al-Maddina which is cultivated in the North West of the Kingdom of Saudi Arabia. However, the most popular date variety is called Khalas which is grown in Al-Hassa in the Eastern Province of Saudi Arabia [25]. Dates are usually consumed with sour milk (plain yoghurt drink) at lunch time or with Arabic coffee as a snack during the day [27,28]. In addition, dates is stuffed with nuts or chocolate and customarily served as a dessert along with Arabic coffee. Dates can also be used for bakery products such as bread, varieties of cakes and biscuits.

Nutritive Values of Traditional Saudi Foods

In Saudi Arabia, the rice is not usually consumed individually but it is served with cooked vegetables and meat in a main dish (Kabsa). These complementary components add valuable nutrients to the consumption of the rice. The nutritive value of Kabsa depends on its three main components, namely, rice, meat and vegetables. In Saudi Arabia, a wide range of rice varieties are available including Basmati rice, Punjabi rice, Mazza rice, Uncle Ben's rice and Hassawi rice [24,29,30]. Hassawi rice is an indigenous reddish brown rice of *Indica* variety. This type of rice is grown and consumed traditionally in the Al-Hassa oasis in the Eastern Province of Saudi Arabia [29]. Hassawi rice by tradition is consumed in Kabsa with cooked vegetables and meat (chicken or lamb). When Kabsa made with Basmati rice (BRK), some of its nutritive values would be considerably different from that Kabsa made with Hassawi rice (HRK). For example, the CHO content in a serving size (150 g) of BRK is about double that found in HRK (43 vs 24 g, respectively). However, the iron content in HRK is approximately 8 times that is in BRK (2,6 vs 0.3 mg, respectively). Despite the fact that Hassawi rice is non-fortified with any minerals, its level of iron is considerably high [29]. This also applies on the wheat based dishes when the whole grain wheat is used which would be a good source of dietary fibre and minerals in Saudi diets. Harees is a good example for that as it is consumed in the form of whole grains. As such, a serving size (150 g) of Harees would provide 16 % and 26 % of the requirement of dietary fibre and iron for adults according to the recommended daily intake (RDA), respectively (Table 1). This would be a substantial contribution to the improvement of the Saudi diets [14,31]. However, finely milled cereal and grain products are recently replaced by whole grains wheat and flour. Moreover, these healthy traditional starchy foods become less consumed.

As mentioned above, Saudi populations habitually enjoy consuming dates at both Rutab and Tamer stages. Dates has nutritional and functional properties and it is known as a good source of simple sugar and dietary fibre [32,33]. Date is customarily served along with Arabic coffee as a snack or with sour milk at lunch time on a daily basis [27,28]. This Saudi traditional practice of ingestion dates, at the same time with drinking sour milk, could have a beneficial effect in reducing glycaemic response for dates and increasing the intake of protein as well [28]. On the other hand, consuming dates with Arabic coffee could have a detrimental effect on blood glucose levels [27]. A serving size (60 g) of dates would provide about 6% of dietary fibre and 13% of iron of the requirement for adults according to RDA [14,31].

The Concept of Glycaemic Index and Insulinaemic Index

The glycaemic index (GI) of foods was initially developed and published in 1981 by Jenkins and colleagues [5]. It helped to demonstrate the physiological impact of CHOs on postprandial blood glucose rather than their chemical features [5,34]. This classification added an important dimension to nutrition and dietotherapy. Therefore, the GI concept is used to rank CHO containing foods according to their immediate impact on blood glucose levels. Accordingly, a classification of GI was proposed by Wolever et al. [35] and within this definition high GI foods are those with an index of greater than or equal 70 in the case of using glucose as a standard reference, while low GI foods have a value less than or equal 55. High GI foods cause a rapid elevation in blood glucose. Research on the health effects of different GI of foods have indicated that a high GI diet and other factors associated with increasing affluence may have assisted in creating and developing chronic disease states [36-38]. However, low GI foods are digested more slowly and the CHO present is converted into glucose at a slower rate, producing a more gradual rise in blood glucose and insulin responses [39,40]. Intervention and epidemiological studies showed that the consumption of low GI food was associated with the reduction of the risk of cardiovascular disease and T2DM [7,8,41,42].

On the other side, insulinaemic index (II) is a rank of CHO containing foods according to their immediate impact on blood insulin levels. The II is significantly (r=0.94; p=0.005) related to the GI [43]. It is evident that low GI diet requires lower insulin demand which plays an important role in the treatment of diseases related to insulin resistance [44-46].

GI and II of Traditional Saudi Foods

Most of published data on GI are based upon analyses carried out in Australia, Europe, Canada and the USA. The GI values of more than 2500 different types of foods have already been reported [47]. However, very few traditional Saudi foods have been tested for the GI [27,29,48]. As such, there is a lack of knowledge about the GI of some traditional Saudi foods. Table 2 illustrates the GI values for some Saudi foods. The GI values of these foods have shown to vary from low (≤ 55) to medium (> 55 and < 70), with exception of Gerish with GI value of 89 [27,29,48,49]. However, the overall GI of most Saudis foods is considered to be low.

Food	GI	II
Baked Motabbaq	56	-
Dates with Arabic Coffee	63	62
Dates with sour milk or yoghurt	29	-
Dates, Khalas variety	55	64
Foul (mashed)	55	-
Foul (whole)	45	-
Fried Motabbaq	52	-
Gerish	89	-
Harees	52	-
Hassawi rice, cooked in water only	59	56
Kabsa	60	-
Klaija eneazaa	58	-
Klaija malakee	51	-
Mahalbia	56	-
Marassia	51	-
Qorsan	61	-
Saleeq	52	-
Siyadiyeh	14	-
Stuffed grapevine leaves	30	-

Table 2:The glycaemic index (GI) and insulinaemic index (II) for some Saudi foods.

Dates variety	GI value	Original	Reference
Birhi	64	Saudi Arabia	[51]
Birhi	50	United Arab Emirates	[47]
Bo ma'an	31- 46	United Arab Emirates	[47,50]
Dabbas	49	United Arab Emirates	[50]
Fara'd	54	United Arab Emirates	[50]
Khalas	55	Saudi Arabia, United Arab Emirates	[27,50]
Khudhary	58	Saudi Arabia	[51]
Lulu	53	United Arab Emirates	[50]
Nabut Seif	64	Saudi Arabia	[51]
Nabut Sultan	51	Saudi Arabia	[51]
Rabiea	55	Saudi Arabia	[51]
Rothana	54	Saudi Arabia	[51]
Rutab Khalas	45- 47	United Arab Emirates	[28]
Sukkary	47	Saudi Arabia	[51]
Sullaj	56	Saudi Arabia	[51]
Suqai	59	Saudi Arabia	[51]

Table 3. The glycaemic index (GI) for some varieties of dates grown in Saudi Arabia and United Arab Emirates.

In addition, the GI of varieties of dates has been measured and it is generally in the low range (31-64). The GI values for varieties of dates at Tamer and Rutab stages are shown in Table 3 [27,28,47,50,51]. Interestingly, the GI of dates can be reduced (Table 2) when consumed with sour milk [28]. However, ingestion dates at the same time with drinking Arabic coffee increased the GI of dates. It has been found that the GI of Khalas dates was increased from 55 to 63 when this type of dates consumed with Arabic coffee [27], but this increase has not been seen on other study [52]. The II value of the Khalas dates also was determined and found to be 64 and 62 for dates without and with Arabic coffee, respectively. It seems that the II for dates has not been effected by drinking Arabic coffee [27]. Another Saudi food in which its II has been measured is Hassawi rice. The II of Hassawi rice has shown to be low with value of 56, in comparison with other varieties of rice such as Uncle Ben's rice, which its II value was 78 [29].

The Relationship between Glycaemic Index and Diabetes Mellitus

The blood glucose is rapidly increased after consumption of high GI foods. In response to this, the body attempts to balance the rise in blood glucose levels by secreting a large amount of insulin. It is considered that repeated overproduction of insulin may lead to insulin resistance in which cells that normally respond to insulin become less sensitive to its effects [53]. Indeed, excessive intakes of high GI foods over a long period are associated with high insulin levels, insulin resistance, a lower concentration of high density lipoprotein (HDL) and hypertriglyceridaemia [44,53-55]. There is a strong positive association between the consumption of high GI of foods and developing risk of T2DM [7,8,56]. High GI foods may alter the risk of T2DM owing to the production of higher blood postprandial glucose concentrations and a greater insulin demand than do low GI foods. It is possible that chronically increased insulin demand may directly increase insulin resistance [7,57]. Indeed, it is now widely appreciated that insulin resistance precedes the development of T2DM. In contrast, low GI diets have been linked with improvement in metabolic control and decreased risk of development of T2DM due to the fact that they are slowly digested and absorbed, producing a gradual rise in blood glucose and insulin levels [37,39]. Low GI diet may also improve insulin sensitivity by minimising fluctuation in blood glucose levels and reducing the secretion of insulin over the day [41]. Replacing a high GI diet with a low GI diet might reduce frequent and rapid rise in blood glucose levels and increase the body's sensitivity to insulin. Studies on the postprandial glucose response to CHO-containing foods have demonstrated that the low GI foods decrease the insulin and glucose response compared with high GI foods, suggesting an increase in insulin sensitivity in normal volunteers and in obese insulin resistant subjects [58]. It has been found that a reduction of the fasting plasma glucose concentration in subjects on low GI diets was significantly more pronounced than in those on the high GI diet [59]. It has also been found that the final values of glycosylated serum proteins (fructosamine) has shown a 7% fall ($p<0.01$) on the low GI diet and a non-significant fall of 2.2% on the high GI diet [55]. Similarly, Frost et al. [60] have found that a significant fall in fasting blood glucose and fructosamine occurred in type 2 diabetic patients treated only by giving advice to lower the GI of the CHO in their diet for 3 months [60]. These results demonstrated greater improvements in glucose control with a low GI diet as compared to a high GI diet occurred. In addition, the effect of consumption of low GI diet was also shown an improvement in glycated haemoglobin (HbA_{1c}). A study on subjects with diabetes found that significantly better HbA_{1c} levels in subjects consuming a low GI diet compared to the high GI diet group [42]. In fact, each 1 % decrease in HbA_{1c} was associated with 21% reduction in the risk of diabetic complications [41].

Indeed, the joint Food and Agriculture Organization (FAO) and World Health Organization (WHO) Expert Consultation Committee advocated the use of low GI diets in the management of individuals at risk of developing diabetes and diabetes-related complications [61]. However, the great health benefit of the low GI foods remains to be fully elucidated.

The Relationship between Traditional Saudi Foods and Diabetes Mellitus

There is evidence that dietary habits and lifestyle play important roles in developing or preventing chronic diseases such as cardiovascular disease, obesity and diabetes. Saudi populations are very traditional and habitually consume the same foods that their ancestors were used to eat for centuries [14]. As mentioned above, most of traditional Saudi foods are based on whole grains wheat and rice. The starch presented in these foods within whole grain structures can inhibit completely the swelling and dispersion of starch, and also partially block access of digestive enzymes [4]. This is an important feature of Saudi starchy foods could provide major contribution to the improvement of Saudi diets in terms of lowering blood glucose and insulin responses where there is a high rate of prevalence of diabetes [16]. Also, consumption of whole grains foods definitely increase the intake of dietary fibre. Dietary fibre, either soluble or insoluble, plays an important role in improving postprandial glycaemic response. This improvement has been found to be due to the effect of dietary fibre on slowing down the digestion and absorption of food [62,63]. Studies have shown a significant association between dietary fibre and decreased risk of DM and supported the protective role for dietary fibre in the development of DM. It has been suggested that grains should be consumed in minimally refined form to reduce the incidence of T2DM [56,63,64]. It is recommended to consume three servings a day of whole grain foods due to its effectiveness in lowering glycaemic response and improving insulin resistant [65].

In Saudi Arabia, as the daily intakes of finely milled cereal and grain products has increased over recent years [14]; there has been a concomitant reduction in the consumption of the traditional starchy foods such as those mentioned on Table 1. It has been considered that refined grains may be associated with increased diabetes risk because these foods tend to have a high GI compared to whole grain containing foods [38]. For example, Harees as a traditional Saudi food had a low GI with a value of 52 [66]. The low GI value in Harees refers to the fact that Harees is digested more slowly and its CHO is probably converted into glucose at a slower rate, producing a lower postprandial glucose concentration and subsequently lower insulin response [4,67]. As mentioned above, consumption such Harees in the form of a whole grains can provide a substantial contribution to the improvement of the Saudi diets.

Saudi patients with diabetes are commonly advised without a sound scientific basis, to avoid the consumption of dates [68]. This is mainly due to the fact that the main sugar in dates is glucose [69] which can be readily absorbed in the human small intestine and thus influence diabetic control. However, the GI for most different varieties of dates as shown in Table 3 is generally in the low range [27,51].

It is important to consider both the GI and II of foods in the dietary management of an individual with diabetes because there are some foods with a low GI but their II is high. Interestingly, the first documentation of the II for Saudi foods was for Hassawi rice and Khalas dates. Khalas dates had a medium II with value of 64 [27], while the II vaule of Hassawi rice was 56 [29]. There was a low insulin response to Hassawi rice which could be due to its higher content of dietary fibre. It is evident that consumption of high fibre diet is associated with a favourable effect on insulin sensitivity and may protect against the development of DM [70,71]. Several studies have included measures of II values because the role of insulin in glucose homeostasis is well known and because of the association between the large insulin demand with a high GI food which has been proposed to be involved in the aetiology of diabetes [8,72-74]. Incorporating the use of GI and II values should be considered in planning the optimal dietary CHOs for people with diabetes.

Conclusion

One of the greatest health problems associated with excess morbidity and mortality around the worldwide is DM. Saudi Arabia is a country with a population of approximately 27 million. Its people have experienced great changes in the last 7 decades because of the discovery of oil. This has resulted in large social changes and now the population is experiencing a high prevalence of DM that is increasing at an alarming rate. One of the main causes for this phenomenon is due to rapid changes in habitual eating patterns, in particular the quantity and quality of dietary CHOs. Several strategies have been investigated to prevent or alleviate the acuteness of this problem. A modification in the type and amount of the dietary CHOs intakes is known to alter the impact of dietary CHOs on the plasma glucose and insulin profiles and this presents a useful strategy to alleviate some of the problems associated with DM.

Despite of the dramatic changes in Saudi habitual dietary patterns, there is still some common place traditional practice that remains, such as the consumption of some traditional foods. It is obvious that traditional Saudi foods produce more favourable metabolic profiles. The traditional foods may have a beneficial effect on plasma glucose and insulin levels owing to the fact that their CHO may be slowly hydrolysed and thus absorbed at a slower rate in the small intestine. These features of staple foods may be important for people with diabetes in Saudi Arabia. A greater understanding of the effects of traditional Saudi foods on blood glucose and insulin levels may lead to more effective lifestyle prevention strategies for DM.

The lower GI and II for most traditional Saudi foods suggest that these foods may have a role to play in the management and prevention of DM. In addition, most traditional Saudi foods contain high level of dietary fibre. It is well documented that dietary fibre has beneficial effects in improving insulin sensitivity and therefore reducing the risk of developing DM. As diabetes is becoming more common in Saudi Arabia, steps need to be taken to address this problem. Nutritional advice, including the use of traditional foods, such as Harees, Marqooq, dates and Hassawi rice on a regular basis, could be given to the general public and in particular individuals with diabetes to overcome this disease. The major practical implication from this review is to encourage the consumption of healthy Saudi traditional foods. Further studies are needed to confirm the impact of long term consumption of traditional Saudi foods on blood glucose and insulin levels in healthy people and those with diabetes.

References

1. Whiting DR, Guariguata L, Weil C, Shaw JE (2011) IDF diabetes atlas: global estimates of the prevalence of diabetes for 2011 and 2013. Diabetes Res Clin Pr 94: 311-321.
2. Musaiger AO, Al-Hazzaa HM (2012) Prevalence and risk factors associated with nutrition-related noncommunicable diseases in the Eastern Mediterranean region. Int J Gen Med 5: 199-217.
3. Alhadd TA, Al-Amoudi AA, Alzahrani AS (2007) Epidemiology, Clinical and Complications Profile of Diabetes in Saudi Arabia: A Review. Ann Saudi Med 27: 241-250.
4. Al-Mssallem MQ, Frost GS, Brown JE (2014) The metabolic effects of two meals with the same glycaemic index but different slowly available glucose parameters determined in vitro: a pilot study. Ann Nutr Disorders & Therapy 1: 1-5.
5. Jenkins DJ, Wolever TM, Taylor RH, Barker H, Fielden H, et al. (1981) Glycemic index of foods: a physiological basis for carbohydrate exchange. Am J Clin Nutr 34: 362-366.
6. Zhang G, Hamaker BR (2009) Slowly Digestible Starch: Concept, Mechanism, and Proposed Extended Glycemic Index. Crit Rev Food Sci Nutr 49: 852-867.
7. Schulze M B, Liu S, Rimm EB, Manson JE, Willett WC, et al. (2004) Glycemic index, glycemic load, and dietary fiber intake and incidence of type 2 diabetes in young and middle-aged women. Am J Clin Nutr 80: 348-356.
8. Salmeron J, Ascherio A, Rimm EB, Colditz GA, Spieqelman D, et al. (1997) Dietary fiber, glycemic load, and risk of NIDDM in men. Diabetes Care 20: 545-550.
9. Willett W, Manson J, Liu S (2002) Glycemic index, glycemic load, and risk of type 2 diabetes. Am J Clin Nutr 76: S274-S280.
10. American Diabetes Association (2014) Standards of medical care in diabetes-2014. Diabetes Care 37: S14-S80.
11. Shaw JE, Sicree RA, Zimmet PZ (2009) Global estimates of the prevalence of diabetes for 2010 and 2013. Diabetes Res Clin Pract 87: 4-14.
12. Wild S, Sicree R, Roglic G, King H (2004) Global Prevalence of Diabetes: Estimates for the year 2000 and projections for 2030. Diabetes Care 27: 1047-1053.
13. Central Department of Statistics (2011) Censuses statistics. Kingdom of Saudi Arabia.
14. Adam A, Osama S, Muhammad K (2014) Nutrition and Food Consumption Patterns in the Kingdom of Saudi Arabia. Pakistan J Nutr 13: 181-190.
15. Alissa EM, Bahijri SM, Ferns GA (2005) Dietary macronutrient intake of Saudi meals and its relationship to classical coronary risk factors. Saudi Med J 26: 201-207.
16. Al-Nozha MM, Al-Maatouq MA, Al-Mazrou YY, Al-Harthi SS, Arafah MR, et al. (2004) Diabetes mellitus in Saudi Arabia. Saudi Med J 25: 1603-1610.
17. Al-Nuaim AR, Al-Rubeaan K, Al-Mazrou Y, Al-Attas O, Al-Daghari N, et al. (1996) High prevalence of overweight and obesity in Saudi Arabia. Int J Obes Relat Metab Disord 20: 547-552.

18. El-Hazmi MA, Warsy AS, Al-Swailem AM, Sulaimani R, Al-Meshari A (1998) Diabetes mellitus and impaired glucose tolerance in Saudi Arabia. Ann Saudi Med 4: 381-385.

19. Fatani HH, Mira SA, El-Zubier AG (1987) Prevalence of diabetes mellitus in rural Saudi Arabia. Diabetes Care 10: 180-183.

20. Eledrisi M, Alhaj B, Rehmani R (2007) Quality of diabetes care in Saudi Arabia. Diabetes Res Clin Pract 78: 145-146.

21. American Diabetes Association (2008) Nutrition Recommendations and Interventions for Diabetes. Diabetes Care 31: S61-S78.

22. Musaiger AO (1987) The state of food and nutrition in the Arabian Gulf countries. World Rev Nutr Diet 54: 105-173.

23. Al-Kanhal MA, Al-Mohizea IS, Al-Othaimeen AI, Khan MA (1994) Nutritive value of some wheat based dishes consumed in the Kingdom of Saudi Arabia. Ecol Food Nutr 32: 219-226.

24. Al-Kanhal MA, Al-Mohizea IS, Al-Othaimeen AI, Khan MA (1999) Nutritive value of various rice based dishes in Saudi Arabia. Ecol Food Nutr 38: 223-235.

25. Ministry of Agriculture (2011) Most popular date varieties in the Kingdom of Saudi Arabia. Ministry of Agriculture, second edition, Riyadh, Saudi Arabia.

26. Ali A, Al-Kindi YS, Al-Said F (2009) Chemical composition and glycemic index of three varieties of Omani dates. Int JFood Sci Nutr 60: 51-62.

27. Al-Mssallem MQ, Brown JE (2013) Arabic coffee increases the glycemic index but not insulinemic index of dates. Saudi Med J 34: 923-928.

28. Miller CJ, Dunn EV, Hashim IB (2003) The glycaemic index of dates and dates/yoghurt mixed meals. Are dates 'the candy that grows on trees'? Eur J Clin Nutr 57: 427-430.

29. Al-Mssallem MQ, Hampton SM, Frost GS, Brown JE (2011) A study of Hassawi rice (*Oryza sativa* L.) in terms of its carbohydrate hydrolysis in vitro and glycaemic and insulinaemic indices in vivo. Eur J Clin Nutr 65: 627-634.

30. Al-Mssallem IS, Al-Mssallem M Q (1997) Study of Glutelin Storage Proteins in Al-Hassawi Rice (*Oryza sativa*). Arab Gulf J Sci Res 15: 633- 646.

31. Musaiger AO (2012) The Food Dome: dietary guidelines for Arab countries. Nutr Hosp 27: 109-115.

32. Al-Shahib W, Marshall RJ (2002) Dietary fibre content of dates from 13 varieties of date palm Phoenix dactylifera L. Int J Food Sci Tech 37: 719-721.

33. Al-Farsi M, Alasalvar C, Al-Abid M, Al-Shoaily K, Al-Amry M, et al. (2007) Compositional and functional characteristics of dates, syrups, and their by-products. Food Chem 104: 943-947.

34. Wolever TM, Brand-Miller J, Abernethy J, Astrup A, Atkinson F, et al. (2008) Measuring the glycemic index of foods: interlaboratory study. Am J Clin Nutr 87: S247- S257.

35. Wolever TM, Jenkins DJ, Jenkins AL, Josse RG (1991) The Glycemic index: methodology and clinical implications. Am J Clin Nutr 54: 846-854.

36. Liu S, Willett WC, Stampfer MJ, Hu FB, Franz M, et al. (2000) A prospective study of dietary glycemic load, carbohydrate intake, and risk of coronary heart disease in US women. Am J Clin Nutr 71: 1455-1461.

37. Jenkins DJ, Kendall CW, Marchie A, Augustin LS (2004) The glycemic index: an overview of its possible role in the prevention and treatment of chronic disease. Blackwell Publishing Ltd. Int J Clin Pract 58: 3-7.

38. Schulze MB, Hoffmann K, Manson JE, Willett WC, Meigs IB, et al. (2005) Dietary pattern, inflammation, and incidence of type 2 diabetes in women. Am J Clin Nutr 82: 675-684.

39. Kalergis M, De Grandpre E, Andersons C (2005) The Role of the Glycemic Index in the Prevention and Management of Diabetes: A Review and Discussion. Canadian J Diabet 29: 27-38.

40. Granfeldt Y, Wu X, Bjorck I (2006) Determination of glycaemic index; some methodological aspects related to the analysis of carbohydrate load and characteristics of the previous evening meal. Eur J Clin Nutr 60: 104-112.

41. Thomas DE, Elliott EJ (2010) The use of low-glycaemic index diets in diabetes control. Br J Nutr 104: 1-6.

42. Heilbronn LK, Noakes M, Clifton PM (2002) The Effect of High- and Low-Glycemic Index Energy Restricted Diets on Plasma Lipid and Glucose Profiles in Type 2 Diabetic Subjects with Varying Glycemic Control. J Am Coll Nutr 21: 120-127.

43. Wolever TM, Yang M, Zeng X, Atkinson F, Brand-Miller J (2006) Food glycemic index, as given in Glycemic Index tables, is a significant determinant of glycemic responses elicited by composite breakfast meals. Am J Clin Nutr 83: 1306-1312.

44. Frost G, Leeds AA, Dore CJ, Madeiros S, Brading S, et al. (1999) Glycaemic index as a determinant of serum HDL-cholesterol concentration. Lancet 353: 1045-1048.

45. Garsetti M, Vinoy S, Lang V, Holt S, Loyer S, Brand-Miller J (2005) The Glycemic and Insulinemic Index of Plain Sweet Biscuits: Relationships to in Vitro Starch Digestibility. J Am Coll Nutr 24: 441-447.

46. Nilsson M, Stenberg M, Frid AH, Holst JJ, Bjorck ME (2004) Glycemia and insulinemia in healthy subjects after lactose-equivalent meals of milk and other food proteins: the role of plasma amino acids and incretins. Am J Clin Nutr 80: 1246-1253.

47. Atkinson FS, Foster-Powell K, Brand-Miller JC (2008) International tables of glycemic index and glycemic load values: 2008. Diabetes care 31: 2281-2283.

48. Ba-Jaber AS (1997) Glycemic Indexes of Some Popular Saudi Arabian Foods. Agriculture Research Center, King Saud University, Research Bullet 66: 5-17.

49. Farhat AG, Moukarzel SR, El-Said RJ, Daher CF (2010) Glycemic index of commonly consumed Lebanese mixed meals and desserts. Asian J Clin Nutr 2: 48-57.

50. Alkaabi JM, Al-Dabbagh B, Ahmad S, Saadi HF, Gariballa S, et al. (2011) Glycemic indices of five varieties of dates in healthy and diabetic subjects. Nutr J 10: 59-68.

51. Ba-Jaber AS, Fares E, Al-Rakban M, Al-Kahtani H, Dafallah A (2006) Glycemic Index (GI) of some popular Saudi Dates and the effect of their composition on the GI. Arabic J Foods Nutr 15: 6-13.

52. Alkaabi JM, Al-Dabbagh B, Saadi HF, Gariballa S, Yasin J (2013) Effect of traditional Arabic coffee consumption on the glycemic index of Khalas dates tested in healthy and diabetic subjects. Asia Pac J Clin Nutr 22: 565-573.

53. Frost G, Leeds A, Trew G, Margara R, Dornhorst A (1998) Insulin sensitivity in women at risk of coronary heart disease and the effect of a low glycemic index diet. Metabolism 47: 1245-1251.

54. Brand-Miller J C (1994) Importance of glycaemic index in diabetes. The American Journal of Clinical Nutrition 60: 48-50.

55. Jenkins DJ, Wolever TM, Collier GR, Ocana A, Rao AV, et al. (1987) Metabolic effects of a low- glycemic- index diet. Am J Clin Nutr 47: 968-975.

56. Sluijs I, van der Schouw YT, van der A DL, Spijkerman AM, Grobbee DE, et al. (2010) Carbohydrate quantity and quality and risk of type 2 diabetes in the European Prospective Investigation into Cancer and Nutrition–Netherlands (EPIC-NL) study. Am J Clin Nutr 92: 905-911.

57. Wilkin TJ, Metcalf BS, Murphy MJ, Kirkby J, Jeffery AN, et al. (2002). The Relative Contributions of Birth Weight, Weight Change, and Current Weight to Insulin Resistance in Contemporary 5-Year-Olds. Diabetes 51: 3468-3472.

58. Frost G, Keogh B, Smith D, Akinsanya K, Leeds A (1996) The effect of low-glycemic carbohydrate on insulin and glucose response in vitro and in vivo in patients with coronary heart disease. Metabolism 45: 669-672.

59. Jarvi AE, Karlstrom BE, Granfeldt YE, Bjorck IE, Asp NG, et al. (1999) Improved Glycemic Control and Lipid Profile and Normalized Fibrinolytic Activity and a Low-Glycemic Index Diet in Type 2 Diabetic Patients. Diabetes Care 22: 10-18.

60. Frost G, Wilding J, Beecham J (1994) Dietary Advice Based on the Glycaemic Index Improves Dietary Profile and Metabolic Control in Type 2 Diabetic Patients. Diabetic Med 11: 397-401.

61. FAO/WHO (1998) Carbohydrates in human nutrition. Report of a Joint FAO/WHO Expert Consultation, 14-18 April, 1997, FAO food and Nutrition paper 66: 1-140.

62. Frost G, Dornhorst A (2000) The relevance of the glycaemic index to our understanding of dietary carbohydrates. Diabetic Med 17: 336-345.

63. Meyer KA, Kushi LH, Jacobs DR, Slavin JJ, Sellers TA, et al. (2000) Carbohydrates, dietary fiber, and incident type 2 diabetes in older women. Am J Clin Nutr 71: 921-930.

64. Stevens J, Ahn K, Juhaeri, Houston D, Steffan L, et al. (2002) Dietary Fiber Intake and Glycemic Index and Incidence of Diabetes in African-Amrican and White Adults. Diabetes Care 25: 1715-1721.

65. Hallfrisch J, Behall K (2000) Mechanisms of the Effects of Grains on Insulin and Glucose Responses. J Am Coll Nutr 19: S 320-S 325.

66. Nasib OM (2003) Effect of chemical component and Methods of Preparation of Some Traditional Saudi Arabian Foods on Glycemic Index. Thesis. King Saud University, College of Food & Agricultural Sciences, Saudi Arabia.

67. Collison KS, Zaidi MZ, Subhani SN, Al-Rubeaan K, Shoukri M, et al. (2010) Sugar-sweetened carbohydrated beverage consumption correlates with BMI, waist circumference, and poor dietary choices in school children. BMC Public Health 10: 1-13.

68. Ahmed M, Al-Othaimeen A, De Vol E, Bold A (1991) Comparative responses of plasma glucose, insulin and C-peptide following ingestion of isocaloric glucose, a modified urban Saudi breakfast and dates in normal Saudi persons. Ann Saudi Med 11: 414-417.

69. Al-Farsi MA, Lee CY (2008) Nutritional and Functional Properties of Dates: A Review. Crit Rev food Sci Nutr 48: 877-887.

70. McMillan J, Brand-Miller J (2006) Low-glycaemic index diets and body weight regulation. Int J Obesity 30: 540-546.

71. Liese A, Schulz M, Fang F, Wolever T, D'Agostino RJ, et al. (2005) Dietary glycemic index and glycemic load, carbohydrate and fiber intake, and measures of insulin sensitivity, secretion, and adiposity in the Insulin Resistance Atherosclerosis Study. Diabetes Care 28: 2832-2838.

72. Englyst KN, Vinoy S, Englyst HN, Lang V (2003) Glycaemic index of cereal products explained by their content of rapidly and slowly available glucose. Br J Nutr 89: 329-339.

73. Wolever TMS, Barbeau MC, Charron S, Harrigan K, Leung S, et al. (2000a) Guidelines for the nutritional management of diabetes mellitus in the new millennium: a position by the Canadian Diabetes Association. Canadian J Diabet Care 23: 56–69.

74. Wolever TM (2000b) Dietary carbohydrates and insulin action in humans. Br J Nutr 83: S97-S102.